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18 November 1983

Worldwide Report

TELECOMMUNICATIONS POLICY, RESEARCH AND DEVELOPMENT

No. 294

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SWEDEN'S ERICSSON SELLS MOBILE PHONE NET TO MALAYSIA, UK

Stockholm SVENSKA DAGBLADET in Swedish 1 Oct 83 p 28

[Article by Per-Erik Landqvist]

[Text] Lund--In the space of 48 hours, the Ericsson Radio Systems Corporation has signed two orders for mobile telephone networks worth 500 million kronor: one from Malaysia (200 million kronor) and one from Great Britain (300 million kronor).

Ericsson Radio's division manager Goran Nordlundh says: "We increased our new orders from 1.3 billion to 4.3 billion kronor between 1980 and 1982. I don't like to speculate by making forecasts, but I feel that the chance of further successful expansion is good."

Nordlundh expects a large number of big new orders to be signed before the end of the year. Far-reaching negotiations are underway in Spain, Holland, Belgium, Great Britain, and elsewhere.

The firm has already gained an entrance to Saudi Arabia and Austria.

Nordlundh disclosed: "We recently received our first orders from major operating companies in the United States, the home of the mobile telephone. Something is probably going to happen in the Far East as well."

Ericsson was the very first company to set itself up in Ideon, Lund's new research and development park. The hiring of new technicians is underway: about 25 were to be on the job by the first of the year, but they are already working!

Goran Nordlundh points out: "We have no time to lose. The demands for high efficiency in the mobile telephone industry are great, and so is the competition for technicians in Sweden."

Like Einar Dahlin, the local manager in Ideon, Nordlundh regards the venture in Lund's research and development park as a logical step in Ericsson's development. Cooperation between Swedish industry and the technical colleges must be expanded.

The distance from idea to product will become shorter and therefore will be covered more quickly.

11798
CSO: 5500/2506

HUNGARY TO BUY TELECOMMUNICATIONS EQUIPMENT, KNOW-HOW FROM SWEDEN

Stockholm DAGENS NYHETER in Swedish 7 Oct 83 p 8

[Article by Kerstin Kall]

[Text] Hungary wants to buy equipment and know-how from Sweden for expanding its telecommunications under the new 5-year plan. Negotiations are underway with L.M. Ericsson for an order worth about 200 million kronor.

Ericsson already has an agreement with the trading organization BUDAVOX for the delivery of telephone exchange equipment.

Hungarian authorities are also interested in Swedish energy conservation technology. Minister of Energy Birgitta Dahl and Hungary's visiting Deputy Premier Lajos Faluvegi held talks on Thursday regarding the possibilities that exist for cooperation in the field of energy.

Other areas in which Hungary is seeking Swedish cooperation are medicine, the food industry, construction, the electronics industry, and so on.

Liberalization

The liberalization of Hungary's economy, which began in 1968, is continuing. That was made clear when Minister Faluvegi attended a meeting with the Export Council and the Chamber of Commerce on Thursday.

Foreign investors can now own a majority share in jointly owned enterprises--the requirement that Hungary have a 51-percent share in joint ventures has been eliminated. The rule requiring Hungarian leadership has also been scrapped.

Lajos Faluvegi explained: "A Swedish-Hungarian enterprise can now have a Swedish manager."

Tax rules have also been changed, and the rules on taking profits out of the country have been made more flexible.

Hungarian enterprises have been given a greater opportunity to make direct contact with foreign partners and to operate on the domestic market with "an international approach to prices and competition."

"Direct Interest"

The minister explained: "Our basic principle is that the right to make economic decisions should be delegated to the level where the best information exists and where there is a direct interest."

The government lays down the guiding principles for development and guides their implementation indirectly, but leaves room for initiative by the enterprise. Or, as Lajos Faluvegi expressed it in his written speech:

"Better use is being made of the market's control mechanism, the price system, and the financial and credit policy, and there is greater reliance on the economic interests of society's individual members."

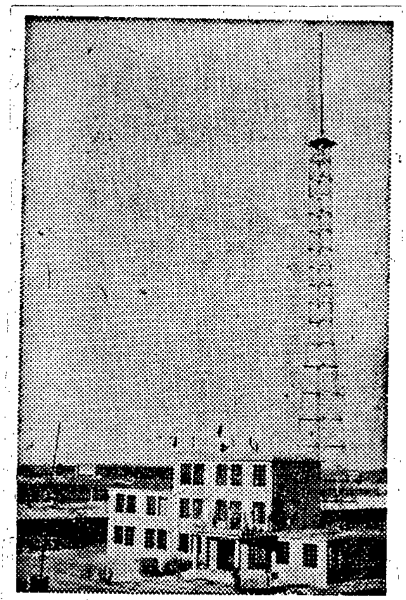
It is also part of the new policy to break up "unjustified monopolies" and to encourage the formation of small and medium-sized enterprises. Last year, about 200 new enterprises were established in that way.

11798
CSO: 5500/2506

LIAONING TELEVISION RELAY STATION COMPLETED

Shenyang LIAONING RIBAO in Chinese 30 Sep 83 p 1

[Text] A ceremony was held recently in Panshan County, Liaoning Province, to mark the completion of a three-story television relay station equipped with a 73-meter-high tower. Built with funds raised by the local population, this relay station, which took 3 years to build, has the same transmission power as most of the municipal relay stations in the province. Its coverage radius is 35 kilometers.



The newly built television relay station in Panshan County, Liaoning Province.

CSO: 5500/4142

BRIEFS

SATELLITE EARTH STATION--A new satellite earth station has been commissioned by Telecom at (?Exeter) Road. The station will provide border communications service between Indonesia and Singapore through the Palapa satellite system. The station has a 4.5-diameter antenna and is expected to improve the quality of telephone service between Singapore and Indonesian border towns. [Text] [Singapore Domestic Service in English 1100 GMT 31 Oct 83 BK]

CSO: 5500/4305

EXPERIENCES FROM CSSR TO GDR DATA TRANSMISSION RELATED

Prague PTT REVUE in Czech No 4, 1983 pp 123-124

[Article by Eng M. Novak, Doctor of Sciences, Eng J. Poupe, Candidate of Sciences, and Eng P. Strnad of the Computer Technology Center of the Czechoslovak Academy of Sciences: "Experience From Experimental Remote Computer Data Transmission Between the Czechoslovak Academy of Sciences and the Academy of Sciences in East Germany"]

[Text] Automation of scientific research and experiments is a significant part of joint programs of science academies in socialist countries. Developing a complex technological system for scientific research and experiment automation including computers, remote data transmission equipment, measuring instruments and computers, constitutes one of the most important objectives in this area. The knowledge obtained in the process not only is significant for science and research, but is immediately applicable in wide areas of industry, communication and national economy and society management. The so-called problem-oriented computing/measuring systems and computer terminal networks constitute one very important problem.

The problem-oriented computing/measuring systems serve to collect data (mostly from experimental equipment), to pre-process and prepare them for further processing in high computer technology and also for remote data transmission. Having been processed either locally or remotely, the data are re-used in the computing/measuring system, either as input information or as data for experiment or technological process control. The computing/measuring systems are usually located at the place where the experiment is conducted or where the technological or other process is monitored and controlled, whereas large-capacity computers processing complex information are located centrally. Therefore, it is expedient to build data transmission networks both with interconnected computing/measuring systems and central connections. Furthermore, it is convenient to interconnect individual large-capacity computer centers. Such connections will facilitate more effective use of the computers in individual centers, allowing problem division and distribution and application of the mutual redundancy method.

Open data transmission networks serve to interconnect diverse hardware, permitting connection of various large-capacity computers as well as terminals or computing/measuring systems.

The Central Institute for Computer Technology of the GDR Academy of Sciences [CIVT] has been developing and testing such an open computer network. The computer network developed in the CIVT connects a number of computers and terminals in the Academy of Sciences' institutes. The topology of this network is shown in Figure 1. The network was named DELTA and the software

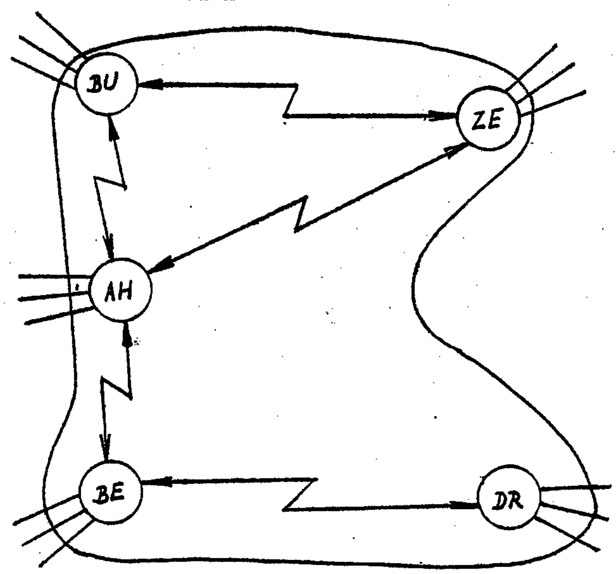


Figure 1. Topology of the DELTA Computer Network

is called KOMET. The individual junctions with connected computers are as follows:

BU--Berlin-Buch--the Institute of Molecular Chemistry, BESM 6
ZE--Berlin-Zeuthen--the Institute of Nuclear Physics, BESM 6
AH--Berlin-Adlershoff--CIVT, BESM 6, EC 1020, EC 1055
BE--Berlin--the second section in Adlershoff--CIVT
DR--Dresden--College of Technology, BESM 6, EC 1020.

The junctions are interconnected through leased fully duplex channels with a transmission speed of 48 kb/s. R 4201 minicomputers of the KRS system (Kleinrechnersystem, a product of ROBOTRON) are used as DELTA's junction computers. These minicomputers have quite an extensive memory ($32 \div 64$ k words at 16 bits each), are relatively fast (instruction execution time $\approx 3 \mu s$) but they have a very limited program (about 30 instructions). However, they are highly reliable and have indexing and indirect addressing capacity, which enhances the program effectiveness.

If we consider that the communication junction computer is used in the computer network for the control of a data flow consisting mainly of logical operations, the R 4201 minicomputer's limited program can be successfully used even to control very fast transmission lines. The DELTA network fully respects Recommendation No X/25. According to this recommendation, communication adapters for log performance are part of hardware as so-called ASM

units, operated on panels inserted into R 4201 frames. Each connected channel requires one ASM unit. For example, in Figure 1, the BU junction contains two ASM units, the AH junction contains three ASM units.

Academies of sciences institutes in socialist countries cooperate in solving problems requiring mutual exchange of information or data processed by computers on both sides. It is desirable that technological means permit very fast data transmission. The traditional ways, e.g., sending magnetic tapes by mail, are useless, because after the time needed for transportation, the data lose their informative value. Building direct connection between the Czechoslovak Academy of Sciences [CSAV] and the GDR Academy of Sciences based on the DELTA network seems to be a possible solution.

The Computer Technology Center [STV] of the CSAV has long been operating a network of TC system terminals, used now by a large number of users in many CSAV institutes. The communication in this network is controlled by a communication processor, built on the basis of the KRS system R 4201 minicomputer. The SVT developed an MC control program for R 4201 computers, which controls all communication functions in the terminal network.

Of all options considered, the KOMET system was chosen to be used for the experimental communication between Berlin and Prague and the junction established in Prague will be connected to the DELTA network operated in the GDR Academy of Sciences. An R 4201 minicomputer was used as the junction computer. It is also used as communication processor in the CSAV terminal network. The R 4201 minicomputer's operational mode was changed by recording the appropriate program.

In order to facilitate the use of the R 4201 minicomputer as a DELTA network junction computer, an ASM unit and a modem, which were again connected to the BE junction through a leased permanent circuit, were connected to it. The transmission speed in this fixed four-wire, fully duplex connection was 1,200 b/s. The technical connection between Berlin and Prague is seen in Figure 2.

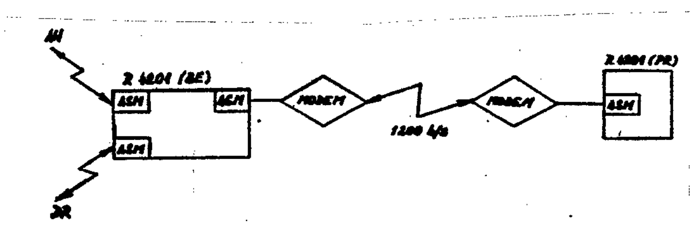


Figure 2. Technical Connection of BE and PR (Prague) Junctions

With regard to routine operation of the CSAV terminal network, which requires a terminal communication processor (the same R 4201 minicomputer is used), the connection between Berlin and Prague was scheduled as shown in Table 1.

Table 1. Schedule for Communication Between Prague and DELTA Network

1)	Pondělí	6 ÷ 10 Tech. 10.30 ÷ 17.30 TER
2)	Úterý	8 ÷ 15 TER ■ KOMET ■
3)	Středa	■ KOMET ■ 8 ÷ 15 TER SVT – VÝZKUM 6)
4)	Čtvrtek	6 ÷ 8 Tech. 8 ÷ 15 TER ■ KOMET ■
5)	Pátek	■ KOMET ■ 8 ÷ 15 TER SVT – VÝZKUM 7)

Key:

1. Monday
2. Tuesday
3. Wednesday
4. Thursday
5. Friday
6. Research
7. Research

Communication between the Prague junction and DELTA network was usually controlled by CIVT workers, who used diagnostic means to evaluate errors in the connection and the stability of the KOMET system.

The LAWINE program was permanently stored in the protected storage area of the R 4201 minicomputer located in Prague. This program is the minimum part of the KOMET system. The memory was organized in such a way that the LAWINE program and some resident modules of the MC program could be permanently stored in the R 4201 minicomputer. The first step is starting the LAWINE program from an address agreed upon in advance, which begins the communication with the opposite junction computer. The function of the LAWINE program is to communicate the information on starting this junction computer to the opposite computer and then to receive the entire KOMET program, which then controls the entire following communication. In this way it is always possible to record a new, updated version of the KOMET program, which is then kept in one work place. The CIVT workers in Berlin maintain an updated version of the KOMET program in their junction computer. From their junction computer they can start the LAWINE program in any junction (or the KOMET program, if a junction computer is operated there) and thus run the KOMET program. During some experiments the KOMET program was recorded from punched tape, since the transmission through the LAWINE program took too long because of the transmission low speed (1,200 b/s--compare with 48 kb/s in the DELTA network).

During the first stage of the experimental remote computer data transmission between Berlin and Prague described above, the KOMET system permitted the following functions:

--to send telegrams typed on the R 4201 minicomputer to Berlin;
--to receive telegrams from Berlin on the same printer;
--to transmit punched tape transparently to Berlin;
--to receive punched tape in the same way.

Punched tape services were used by some CSAV institutes to transmit information processed by computers. The first stage described above took place

from May 1982 to October 1982 and covered about 610 operational hours with average transmission speed about 3,000 packets per hour (the packet's length was up to 254 bits).

No error was made during the transmission, the experiment was interrupted only four times because of power shutdowns (once in Berlin, three times in Prague).

During the discussion of the experiment's first stage it was decided to carry out the second stage, based on utilization of switched connection. Articles (1) and (2) present detailed analysis of the results from the first stage of the experiment.

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9814
CSO: 5500/3004

BRIEFS

SATELLITE STATION FOR OLYMPICS--Sarajevo, 4 Nov (TANJUG)--An auxiliary satellite station has been mounted in Sarajevo, the host-town of the February 1984 winter Olympic Games. The station will enable a good transmission of the winter Olympics for viewers in the United States and Puerto Rico. The new "Jugoslavija 2" communications satellite station in Ivanjica, some 200 km from Belgrade, and the Sarajevo auxiliary station will ensure a good reception in Central and North America regardless of satellite channels possibly being overloaded. The Sarajevo station has been built by a team of the U.S. ABC TV Network. ABC has exclusive rights for the transmission of the games in the U.S. The "Juvoslavija 2" land station, put into test operation recently, will make it possible for TV viewers worldwide to watch the Sarajevo games. [Text] [LD041058 Belgrade TANJUG in English 0954 GMT 4 Nov 83]

CSO: 5500/6

DETAILS REPORTED ON NEW RADIO ANTILLES SERVICE

Bridgetown SUNDAY ADVOCATE in English 2 Oct 83 p 6

[Text]

From yesterday the Montserrat-based Radio Antilles introduces to the entire Eastern Caribbean a unique and most progressive concept in broadcasting — a bilingual service in French and English, which will be transmitted simultaneously on three medium-wave frequencies: 930 KHz,, 1450 KHz and 740 KHz covering wholly, the Caribbean — from Puerto Rico down to French Guiana.

On April 20, 1983, Radio Antilles celebrated its 20th anniversary and was much praised by Caribbean leaders for its high standard of programming during the past two decades. Special recognition was made of its English programme for playing such a vital role in the integration process of Caribbean people by offering to and from all Caribbean territories, reliable, comprehensive and balanced information. Antilles Radio Corporation is operating a 200 000 watts transmitter for its English programme, a 20 000 W transmitter for its French programme and a 10 000 W transmitter in St. Vincent as relay for Martinique.

Radio Antilles operates a short-wave transmitter also, in Montserrat, for Radio Deutsche Welle in Cologne, West Germany.

With its tremendous output Radio Antilles is regarded as the most powerful commercial radio station in the entire Western hemisphere. The decision now to put, on all its AM-transmitters, one bi-lingual programme, is a clear indication to extend the so successful broadcasting concept of the past, to the French territories of the Caribbean by breaking down the language barriers. The entire broadcasting staff of Radio Antilles has been re-organised forming six mixed teams, English-French, who will be from 6 a.m. until 6 p.m. without broadcasting break on the air. News will be presented every hour including correspondents' reports, from all Caribbean English and French-speaking territories.

The Corporation will start its new programme in recently completed and ultra-modern equipped studios located in Plymouth. As of yesterday the "Big RA", "The Spirit of the Caribbean," "The Caribbean Information Centre" will address itself as "Radio Antilles — The Voice of the Caribbean-La Voix des Caraibes."

CSO: 5500/7503

CARIBBEAN BROADCASTING CORPORATION PLANS EARTH STATION

Bridgetown THE NATION in English 7 Oct 83 p 1

[Text]

THE Caribbean Broadcasting Corporation (CBC) has announced plans to build a $800 000 television earth station to facilitate reception and subsequent transmission of "a wide variety of satellite-originated television programmes."

The state-run colour system said in a statement that it was about to purchase and install a 36 foot (in diameter) "dish" antenna and associated equipment for recording the programmes/or transmitting them live.

The station gave no indication of exactly how it proposed to use the earth station, but the CBC board is known to have drawn up a plan — submitted to the Information Ministry — calling for the addition of several channels possibly in a cable tv system that would see such subscribers pay a modest fee for the extra programming.

The CBC television system has operated only one channel since its inception in 1964. Wednesday night's announcement on TV also said that contracts were signed this week for the construction of a new studio complex for CBC's AM radio service away from the TV system. The two are currently housed in — very cramped — conditions at Pine Hill, the statement said.

No projected cost was given for the new radio centre.

The statement said that new radio transmitters that double the station's present 10-kilowatt power output are in the final stages of installation and would be in operation by monthend.

The transmitters plus ancillaries, including a new standby power generator to help keep the station on the air during electricity outages, cost $1 million.

CSO: 5500/7503

TELEBRAS HEAD PRIORITIZES TECHNOLOGY, NOTES LATEST PROJECTS

Sao Paulo VEJA in Portuguese 19 Oct 83 p 128

/Text/ Inasmuch as the complete domination of technology is more important than capital, as observed by Gen Jose Antonio de Alencastro e Silva, president of TELEBRAS /Brazilian Telecommunications, Inc./--the country's second largest state holding company--the company is on the right path. With an investment of 511 billion cruzeiros, TELEBRAS is presently carrying on five new development projects in addition to its expansion plans which include nearly all its 29 subsidiaries; moreover, it is constantly concerned with the objective of achieving another positive result in its next balance sheet. "Despite the difficulties, we have every reason to believe that we shall close this fiscal year with a good profit, which, last year, amounted to 204 billion cruzeiros," Alencastro e Silva foresees.

In the technological sector work is being concentrated at the TELEBRAS Research and Development Center in Campinas. There, the most recent project is the data processing communications network which will provide for the interconnection of all the country's computer systems--and, in a second phase, for a hookup with systems abroad. In practice, all companies or institutions which resort to the system, which will be ready in 1985, will be able to benefit from an exchange of entire packages of continuous information from their respective data banks. But Alencastro e Silva's favorite project is the Tropico--a telephone exchange which will be completely electronic and controlled by computer, a technology heretofore enjoyed only by a few industrialized countries.

"In technological terms that telephone exchange will represent for telecommunications what the Bandeirante plane represents for the Brazilian aeronautics industry," the general says. "The first exchange, with a capacity for 1,000 subscribers, will operate for experimental purposes in the interior of Sao Paulo and in the Federal District," he advises. To carry out those programs, TELEBRAS will invest about 11.4 billion cruzeiros in the Research and Development Center this year, maintaining as a parameter for its application in that area a level of 1 percent of the overall income forecast for this year--1.4 trillion cruzeiros. Most of the total investment of 511 billion cruzeiros will be used to expand

the telephone network--380,000 new terminals--and in its maintenance. "And all of this with our own resources," Alencastro e Silva says with pride, advising that until August there were 9.5 million telephones installed in the country compared with 2.28 million in 1972, the year when TELEBRAS was founded.

8568
CSO: 5500/2013

CUBAN RADIO INTERFERENCE DECRIED AT INTER-AMERICAN MEETING

Sao Paulo O ESTADO DE SAO PAULO in Portuguese 20 Oct 83 p 16

/Text/ Rio de Janeiro--The Cuban Government has installed powerful medium-wave radio transmitters which are causing interference in the frequencies of other radio transmitters located in various countries of the Americas. This denunciation is being made by the Inter-American Association of Radio Transmission at its 16th general assembly which is ending its sessions today.

With the participation of 80 delegations from various countries in addition to Brazil, the assembly is examining the behavior adopted by certain governments, interfering in the hemispheric radio transmissions. The assembly will also discuss the freedom of expression of radio transmission in various countries, the action of pressure groups which is affecting that freedom of expression, transmissions directly by satellite and the proposal of a new world order in communications.

Yesterday, the new members of the organization's board of directors were elected, to serve until 1985; in this connection, Brazilian Luiz Eduardo Borgerth, vice president in charge of television at ABERT (Brazilian Association of Radio and Television Companies), was unanimously elected president of the Inter-American Association of Radio Transmission, which includes about 15,000 broadcasting companies in the Americas.

Interference

As in the case of Cuba, Nicaragua was denounced for the same reason: not respecting international regulations and interfering in the radio transmissions of other countries. In reprisal, the United States stopped its preparations for setting up a powerful radio transmitter which was to be called Radio Marti and was to transmit programs and news in Spanish, thus, over the long range, attempting to neutralize the transmissions coming from Cuba and Nicaragua.

The association believes that the U.S. position may make the solution to the problems of interference more difficult and give rise to a serious problem and recommends that "the present regulations of the International

Communications Law be respected." The participants at the assembly are advising the governments of the hemispheric countries to promote multilateral agreements in this connection.

ABERT president Joaquim Mendonca, who presided over the meeting, said that we must repudiate "any new order which does not respect and promote the basic principle of freedom of communications, pluralism of opinion and private initiative." And he requested that radio transmission adopt everywhere, whenever possible, the disclosure of programs for the improvement of teaching and education.

9568
CSO: 5500/2013

FIRMS ESTABLISH CONSORTIUM FOR EXPORTS TO LATIN AMERICA

Sao Paulo O ESTADO DE SAO PAULO in Portuguese 20 Oct 83 p 32

/Text/ Yesterday, six national data-processing firms signed a protocol of participation in a consortium for exports to Latin America. The consortium is to be headed by Informatica Latino Americana S.A. Importadora e Exportadora, also established yesterday, with capital made up 40 percent by OPT /expansion unknown/, 40 percent by Jap Informatica, of the Data Consult group, and 20 percent by the Argentine partner, Carlos Bruno. The objective is to arrange for the export of Latin American products and services in the telecommunications and data-processing sectors. According to Salvador Perroti, one of the shareholders, the consortium resulted from an appeal made by the Brazilian Government and an effort carried out with the Argentine Government to establish a channel of business relationship between the two countries.

The first phase will be to open an office in Buenos Aires to attract Argentine business people, and, during the first year--with an initial capital of 60 million cruzeiros--the enterprise hopes to obtain contracts ranging somewhere between $3 million and $5 million. Itautec, Standard Electronics, Coincisa, Tecnocop and Microdigital can offer products in the telephony sector--microns, videotests, banking automation systems, modules, printers, interfaces, micropersonnel, etc. The first customer will be Argentina; then will come Paraguay, Uruguay, Chile, Peru, Venezuela and Colombia.

The deal also includes the intention to establish joint ventures with joint capital to set up companies in Argentina, since that country also intends to create a market reserve in the data-processing field. Another interesting aspect of the agreement is the possibility of exchanging other products. With the slogan, "Interchange," Brazil will be able to exchange data-processing equipment for oil, wheat, etc.

Brazil's technological advance in this sector can be illustrated with the banking automation segment which already include 30 banks in the country and which gives the traditional system 3 more years of usefulness,

in the opinion of Celso Mellon Raggio, of BRADESCO /Brazilian Discount Bank/. This firm, which will have 200 branches automated this year, is now launching Telebradesco, a system to be used in the subscriber's home. Eight firms have already installed terminals, and the 1,500 users of videotext will also be able to use the system.

Up to now, BRADESCO has invested 30 billion cruzeiros in the data-processing sector, and its philosophy is not directed toward production but rather toward obtaining the total capital of Digilab, which, together with SID /Information and Documentation Service/, is its biggest supplier. In this respect, Raggio believes that the present market reserve policy is sound inasmuch as it has enabled our national industry to obtain greater capacity and be more competitive on an international level.

BRADESCO's ventures range from magnetic paper, with the possibility of obtaining extracts, to instantaneous computer printouts, purchase by telephone, remote control consultation for storeowners, etc.

8568
CSO: 5500/2013

BRIEFS

LONG-DISTANCE EXCHANGES FROM ERICSSON--Within the past few days, Ericsson has signed contracts with Colombia's National Telecommunications Enterprise to supply AXE long-distance exchanges for Bogota and Barranquilla. The two contracts are worth about $15 million plus 285 million Colombian pesos, with the latter amount being earmarked for local production at Ericsson's plant in Bogota and for installation. In this first expansion of the system, the AXE exchanges will be designed for a total of 29,000 lines and will also provide 130 operator positions. [Text] [Stockholm SVENSKA DAGBLADET in Swedish 23 Sep 83 p 25]
11798

CSO: 5500/2507

NATIONAL TELECOMMUNICATIONS INVESTMENTS DETAILED

Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 7 Oct 83 p 2

[Text] In spite of reduced income from the oil business, Saudi Arabia is continuing to invest heavily in the expansion of telecommunications (See also the survey in the 11 December 1981 issue). Significant contracts have been let for the expansion of all telecommunication areas, above all to firms in Western industrial countries. By the summer of 1983, the number of telephone connections had risen to 1.2 million, and the telex connections to 30,000. There are now ten satellite stations for stationary and mobile connections. This now makes Saudi Arabia the fourth largest user of the Intelsat system. There is also direct dial telephone communication with 141 countries. German firms are also taking part in the development of the Saudi Arabian telecommunications system.

The last large contract (300 million dollars) for the expansion of the telecommunications net was received just recently in September 1983 by a consortium of Italian firms under the leadership of the national firm, Stet. Also in the consortium is Sirti, Milan, in which the state holding company, IRI, with 50 percent, and the Pirelli SpA., have a share. Sirti will deliver over 2,500 kilometers of cable and set up 40 switching centers and other installations. For part of the contract, which involves telecommunications from Mecca to Taif, the royal summer palace, glass fiber cables will be used. The total contract is to be completed in two years. In addition, a year of maintenance is included. Sirti is already represented in Saudi Arabia by its subsidiary, Saudi Arabian Telecommunications Company (SARTELCO) in Riad. It is responsible for the operation of the long range telecommunications net.

Cable and Wireless Saudi Arabia Ltd., Riad, a subsidiary of British Cable and Wireless Ltd., London, received a contract in August 1983 to the amount of 50 million Saudi rials (one Saudi rial is about .76 deutschmarks) for the operation and maintenance of the national and international satellite system in Saudi Arabia. The contract also includes the creation of a specialized organization that is to be entermeshed with the whole Saudi Arabian telecommunication network. The maintenance and operation contract of Cable and Wireless Saudi Arabia Ltd. runs until September 1985.

Before this, in June 1981, Cable and Wireless Ltd. was entrusted with the execution of the second phase of a project that involves the construction of

a telecommunications network for the National Guard. The contract had a value of 200 million pounds sterling, just as did the one in April 1978 for the first phase.

The Canadian firm, Bell Canada Enterprises, signed a new management contract in the spring of 1983 for a period of five years. Its value is said to be 1.6 billion Canadian dollars. At present, about 700 Bell Canada Interprises workers are active in Saudi Arabia to ensure the smooth operation of the telecommunications sector. The previous five year management contract ran out in December 1982.

The Swedish Telefonaktiebolaget LM Ericsson, Stockholm, was entrusted with the construction of a telecommunications network for the militarized city, King Chalid, which lies in the northern part of the country. This task was given to the company in March 1983 by the Saudi Arabian Ministry for Defense and Aviation. The total value of the contract amounts to about a billion Swedish kronor. A partial assignment to the amount of 170 million Swedish kronor was first carried out involving a digital telephone system of the AKE type with 6,000 lines, the construction of a city cable net including telephone equipment and certain transmission stations.

The American firm, Collins Systems International, Inc., which belongs to the Rockwell International Corporation system, received a contract in February 1983 to the amount of 97 million dollars. It involves the delivery of radio relay stations and their servicing. The American firm will do the engineering, installation, and testing of microwave equipment in more than 160 relay stations. The project is to be finished in December 1985.

In the area of telex traffic, Siemens AG, Munich/Berlin, is dominant in Ssudi Arabia. After a first contract in December 1981 for two large EDS stations for telex transmission with 10,000 system connecting units each and three small EDS stations, the communications technology section of Siemens AG received in the spring of 1983 an additional contract for another large installation with 4,000 system connecting units. Its location will be Dammam. The two others will operate in Riad and Djidda and are to be ready for operation this year. The installation in Dammam is to go into operation in 1984. With this, the total telex traffic will run over Siemens installations. By the spring of 1983, Siemens AG had also delivered a total of 27,000 electronic teletypes to Saudi Arabia.

The engineering advisory firm, Deutsche Telepost Consulting GmbH (Detecon), Bonn, a cooperative undertaking of the German Federal Post Office, the German Bank AG, the Dresdner Bank AG, and the German Construction and Commerce Bank, was recently included as an associate partner in the further planning of the Saudi Arabian telex traffic. Besides this, Detecon received a subcontract for the installation of a telephone and telex network in the new industrial location of Yanbu on the Red Sea. Earlier it had already been entrusted with giving telecommunications technical advice to the large oil company, Aramco. Detecon also supervised the installation of a telephone network in the new diplomatic quarter of the capital city of Riad and took over at the end of December 1980

the operation of the Saudi Arabian telex system for a period of three years.

The Dutch Philips Telecommunications Industry, B.V., Hiversum, and the Swedish Ericsson group received a joint contract in February 1982 worth 425 million gulden for the delivery and installation of 18,000 mobile telephones and 48 telephone exchanges in 23 cities and along the roads Djidda-Medina, Djidda-Mecca, and in the area of Riad. With this, the partnership of the two firms booked its sixth contract in a period of five years. All in all, the value of the contract rose to about 11.5 billion gulden. Workshops for the installation and maintenance of the equipment will be set up in seven larger cities.

The French firm, CIT-Alcatel, Paris, first received a contract in 1980 for the delivery and installation of a telephone exchange of the E-10 type with 40,000 connections for the new industrial location of Jubail on the Arabian Gulf. In 1982 a contract followed to the amount of 120 million French francs for the delivery of two further telephone exchanges.

In June 1983 the Saudi Arabian Ministry of Post Office, Telegraph, and Telecommunications engaged the Italian firm, Italcable, Rome, to supervise the expansion of the radio relay net. The expansion includes, among other things, the delivery and installation of about 150 radio relay poles. The value of the contract for Italcable, which belongs to the nationalized IRI group, amounts to 24 million dollars. American Telephone and Telegraph International (ATT) received the contract for the construction of the radio relay net for 377.5 million dollars in August 1982. A construction time of 30 months will be necessary for this project. The present radio relay net was laid by the American firm, Western Electric (WE), a subsidiary of ATT.

9124
CSO: 5500/4502

PRESIDENT COMMISSIONS NEW RADIO TRANSMITTERS

MB031518 Gaborone Domestic Service in English 1125 GMT 3 Nov 83

[Text] The president, Dr Quett Masire, has said that the Batswana will for the first time have choice between local and foreign radio broadcasts when Radio Botswana completes its shortwave expansion program by the middle of next year. The president was speaking at the commissioning ceremony of the first of the four 50-kw shortwave transmitters at the [word indistinct] transmitting station this morning.

The president said that by the middle of next year the shortwave expansion program should be complete with the installation of the remaining three 50-kw shortwave transmitters. The president said this would represent a big step forward in the development of radio broadcasting in Botswana and that all radio listeners would be able to pick up the radio signals clearly at all times.

Dr Masire said that the brief ceremony marked yet another milestone in the development of radio broadcasting in the country. The president recalled that in 1970, 4 million pula was set aside for the purpose of improving radio coverage. The president also pointed out that another improvement to Radio Botswana's broadcasting capacity had been the use of the VHF-FM transmitter for the Gaborone area and added that outside Gaborone there are new shortwave aerials to carry the radio signal further than it could reach before. The president stressed that Radio Botswana is a vital instrument in the promotion of national unity, providing education, information and entertainment. The president took the opportunity to stress to the staff of Radio Botswana at the ceremony that this expensive and sophisticated equipment represents an opportunity [words indistinct] to other fronts of development in our country.

The president added in an emphatic tone: Handle it with care, and put it to good use. He said the radio was meant for the benefit of the listener and not for the amusement of the operator.

After the speech the president went to switch on the transmitter to mark the official commissioning. He was then taken on a conducted tour of the transmitter complex by the acting director of information and broadcasting, Mr (Makgekgenene). The ceremony was attended by the vice president and minister of finance and development planning, Mr Mmusi, and some cabinet ministers, including the minister of public service and information, Mr Kwelagobe.

CSO: 5500/22

CAUSE FOR MYSTERY ABOUT BOPHUTHATSWANA TV SOUGHT

Johannesburg RAND DAILY MAIL in English 17 Oct 83 p 10

[Article by James McClurg, RAND DAILY MAIL ombudsman]

[Text] WHY all the mystery about Bophuthatswana's television service?

According to Friday's Rand Daily Mail, "reliable sources" have confirmed that the service is to go on the air on December 31, one day ahead of the date originally scheduled. No detailed information whatsoever is so far available.

Bophuthatswana's Minister of Works, Mr M A Kgomongwe, who is chairman of the Cabinet Committee in charge of TV, has promised an official statement "in a few days' time".

Two or three months ago the technical agreement between Bophuthatswana and South Africa was reported to be in its final stages of negotiation. Such an agreement is necessary because the world does not recognise Bophuthatswana as an independent state. It has to depend on South African willingness to let it use frequencies allocated to the Republic by international agreement.

There has been complete silence about the progress of these talks.

Even now, Mr Kgomongwe's promise of an official statement appears to have been given with some reluctance in response to questioning by the Mail. He would not comment on reports that his government has negotiated some special link with the BBC.

The main focus of interest remains the vital agreement with South Africa. Have the negotiations ended in a satisfactory understanding? If so, it is odd that the public has been told nothing about it.

There was plenty of room for disagreement. Was South Africa trying to impose unacceptable restrictions in exchange for operating the transmitters? On the other hand, was Bophuthatswana balking at giving South Africa power of life and death over the service through its power to cut off transmission?

These are essentially political questions. Once agreement had been reached on them, the technical details could have been speedily settled.

To say that the media world is awaiting Mr Kgomongwe's announcement with interest would be the understatement of the week.

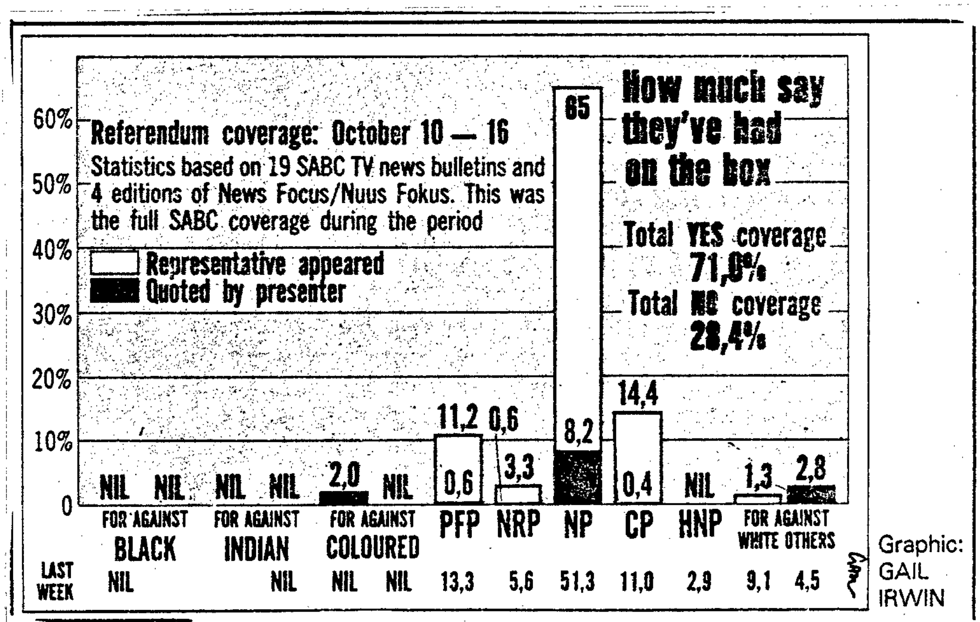
CSO: 5500/16

TELEVISION'S 'BIASED' COVERAGE OF REFERENDUM SHOWN

October 10-16 Coverage

Johannesburg RAND DAILY MAIL in English 18 Oct 83 p 8

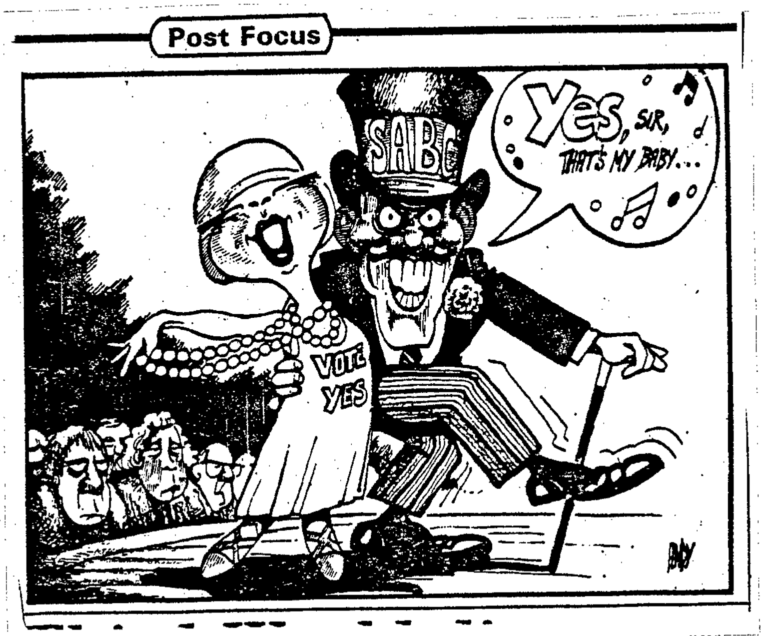
[Text]



Uncaptioned Cartoon

Port Elizabeth EVENING POST in English 7 Oct 83 p 6

[Text]



CSO: 5500/16

BRIEFS

BEECHAM ORDERS SHARENET--Beecham has ordered the first commercial installation of SharNet from TelkorData. It will use the communications network, one of the few not dedicated to specific microcomputers, to interconnect IBM personal computers and automate its Isando warehouse. "The system means a time saving of up to nine months and reduced budgeted costs of R100,000," says Mr Alan Buckley, the data processing manager for Beecham. "The personal computers will operate barcode laser-scanners and control conveyors allowing personnel to accurately track receipts and issues." [Text] [Johannesburg RAND DAILY MAIL in English 18 Oct 83 p 7]

CSO: 5500/16

RTZ TO BROADCAST TO ARAB COUNTRIES, COMOROS

Dar es Salaam DAILY NEWS in English 19 Oct 83 p 3

[Article by Sukhdev Chhatbar]

[Text] RADIO Tanzania Zanzibar, (RTZ) by the end of next year begin external broadcasting services after the installation of two 50-kilowatt shortwave transmitters at Dole, some nine kilometres out of here.

The Director of the Department of Information and Broadcasting, Ndugu Tatu Ally, said yesterday that installation of transmitters was expected to be completed by October next year.

Tatu Ally told visiting Tanzania School of Journalism (TSJ) second-year students that the transmitters were being installed by fifty experts from China. She said the building that will house the transmitters had been completed.

The Director said after installation, Zanzibar would be able to broadcast programmes to Arabian countries and the Comoro Islands in English and Arabic.

Work on the transmitters, which started last year, was originally scheduled to be completed this year, but it has been delayed due to current economic problems.

Meanwhile, Radio Tanzania Zanzibar has purchased a 10-kilowatts medium-wave transmitter from the United States to boost local broadcasting capability. Previously, the radio had 2.5 kilowatts transmitter.

CSO: 5500/17

DODOMA-MWANZA MICROWAVE LINK TO BE COMPLETED NOVEMBER 1983

Dar es Salaam DAILY NEWS in English 21 Oct 83 p 1

[Article by Attilio Tagalile]

[Text]

INSTALLATION of a micro-wave link between Dodoma and Mwanza will be completed before the end of next month, the Minister for Transport and Communications, Ndugu John Malecela, has said.

Ndugu Malecela told newsmen in his office in Dar es Salaam yesterday that the completion of the installation work would, apart from solving communications problems between Dodoma and Mwanza, also bring about a smooth telephone link between the lake regions and Dar es Salaam.

The new link, the Minister said, would increase telephone lines from 60 to 360. Apart from the 300 extra lines, the lake regions would have 600 more lines which would provide room for future expansion, he said.

The Minister explained that at present 360 new telephone lines would be more than enough for Mwanza which, he said, would continue to serve as a major telephone exchange for Bukoba, Musoma, Shinyanga and Tabora.

He said the implication of the installation of a micro-wave link between Dodoma and Mwanza was that the completion of the project would also improve communication between Dar es Salaam and Tabora, Shinyanga, Musoma and Bukoba.

Commenting on Kagera region, the Minister said installation of a micro-wave link had already passed through Biharamulo.

Workers and technicians were presently constructing buildings for housing booster equipment in Bukoba and Muleba districts, he said, adding that installation of a micro-wave link in the region would be completed before the end of next year.

The completion of the installation of a micro-wave link between Kagera Region and the rest of the country, will bring to an end serious communication problems to and from the region.

At present, Ndugu Malecela said, the lake regions were dependent on "tropospheric system" which became obsolete since 1975, "but we continued to use it in the absence of the micro-wave system", he added.

He explained that the problem with the tropospheric system was that its operation revolved through the throwing up of sound waves which were inturn taken up by huge saucer like equipment installed on booster stations in the regions.

The problem with this type of system, he said, was that communication functioned to the latter only during good weather. Once the weather was intereferred by other problems such as thunderstorms, the system could not function, he said.

CSO: 5500/121

BRIEFS

NEW DIGITAL EXCHANGE--Fifty more telephone channels and 42 telex links between Zanzibar and Dar es Salaam exchange will become operational from November 5, this year when the new digital exchange starts functioning. The Tanzania Posts and Telecommunications Corporation (TPTC) resident Director for Zanzibar, Ndugu Charles Lutakamale, told Shihata that the link would supplement the present telephone strength of 36 to 86 channels. He said a new UHF radio system would be used to link Zanzibar and Dar es Salaam. Currently, there are 24 telex lines. Ndugu Lutakamale said plans were underway to increase telephone links between Zanzibar and Pemba currently served by 12 channels. Meanwhile, the old auto manual boards will continue to be used by the Zanzibar Telephone Exchange pending replacement in future. Ndugu Lutakamale said TPTC intended to replace the boards which were not designed for purposes of a digital exchange. The computerised exchange, which is nearing completion, will begin operation from November 5 with 3,000 telephone lines. [Excerpt] [Dar es Salaam DAILY NEWS in English 25 Oct 83 p 1]

CSO: 5500/121

EXISTENCE OF FREE PRESS IN WEST DENIED; NEW WORLD INFORMATION ORDER URGED

Moscow APN DAILY REVIEW in English 15 Sep 83 pp 1-8

[Article by Yu. Kashlev, doctor of historical sciences: "'Freedom of the Press': the End of a Legend:]

[Text] Mankind is now going through a difficult and anxious period of its history. Touching on the current developments in international relations, at the June (1983) Plenary Meeting of the Central Committee of the Communist Party of the Soviet Union, Yuri Andropov noted: "We have witnessed an unprecedented intensification of the struggle between the two world social systems." The imperialist reactionary forces, primarily the ruling circles of the United States, have launched a psychological war of unprecedented scale against real socialism. The propaganda machinery of capitalist countries has given the mass media an important role in the comprehensive campaign of undermining the world of socialism through conspiracy, sabotage, provocation and intervention into the internal affairs of sovereign states.

The chief current development observed in the mass media of capitalist countries is the increasing concentration of the press, radio and television under the control of monopoly capital. Today these means of propagandizing the people in the interests of the ruling class have been very actively used against the forces of socialism and progress on the international scene.

The days when some enthusiastic individual, even a very wealthy one, could break into the Western mass media market with a new publication or set up a radio or television network are gone forever. Nowadays the information industry is dominated by major corporations which have long divided the market among themselves, but which continue furiously fighting for advantageous positions. For instance three giants, NBC, ABC and CBS, actually dominate the large-scale TV industry of the United States, which consists of more than 700 commercial stations and transmits almost 5,000,000 hours of programming every year.

The U.S. newspaper world has quite a few monopolies; namely, about 150. However, all of them are divided among a dozen of the leading monopolies which incorporate scores of newspapers every year. For example, the Knight-Ridder Company issues 34 newspapers, Gannett publishes 86 papers and Thomson Newspapers puts out 75 of them. All in all, the monopolies issue 45,800,000 copies of daily papers (making up 72 percent of all daily papers in circulation) and 41,200,000 copies of Sunday papers (making up 75 percent of all Sunday papers

in circulation. Some time ago the United States boasted many rival and independent newspapers, abiding by the "freedom of the press" principle. Today the newspapers of almost all U.S. cities belong to monopolies.

Of late, super-giant, or "dinosaur" companies, as THE U.S. NEWS AND WORLD REPORT called them, have appeared in the mass media. Each of them owns newspapers, magazines, radio stations, television channels and a cable-television network. The biggest deal of recent times was the $646,000,000 purchase of the second largest U.S. cable TV network by the Westinghouse multinational corporation.

The same thing occurs in other imperialist countries. In Great Britain, most of the newspapers are controlled by four concerns. In Italy, even major papers belong to industrial corporations. In 1981, there was a great sensation in France when the leading military and industrial company, Matra, bought the Hachette chain of newspapers and publishing houses, one of the biggest in Western Europe. It issues one out of every five books and one of every ten magazines in France and has distribution networks in 30 countries.

So, a giant military, industrial and propaganda complex has appeared in France for the first time in its history. Side by side with the manufacture of missiles and other arms and communications equipment, it now controls numerous periodicals, their distribution agencies, radio stations, etc. Discussing the propaganda output of this complex, L'HUMANITE points out that from now on even more prevalent in its publications will be anti-Sovietism, NATO propaganda, the encouragement of war hysteria, and attacks on the French Communist Party.

It is often said in Western countries that the mass media industry is at the service of big business. It is worse than that, in fact. The mass media industry is part of big business. Well known is the statement made by Roy Thomson, owner of one of the mass-media empires, that nowadays the possession of a television channel is tantamount to owning a licence for printing money.

Advertizing is the life-line between the press and big business. In the United States, advertizing yields a profit of dozens of billions of dollars--more than the national income of most of the developing countries. Several years ago 1.14 percent of the cost of all manufactured goods was spent on advertizing in Japan and 0.8 percent in France. By controlling advertizing, the monopolies of a given country either support or undermine publishing or broadcasting agencies, actually deciding their fate.

What is more, behind the publishing monopolies as well as radio and TV companies there stand even bigger giants, the U.S. electrical corporations. Having monopolized the manufacture of communications equipment and electronics, they now direct the activities of the mass media through a whole system of invisible levers.

The manufacture of communications equipment is monopolized by 15 multinational corporations considered the biggest in the world. Among them are, in the United States, International Business Machines (whose annual turnover is approximately 15 billion dollars and whose factory and office workers number

290,000), General Electric (13.4 billion-dollar annual turnover and 375,000 workers) and International Telegraph and Telephone (11.4 billion dollar annual turnover and 376,000 personnel); in the Netherlands, Philips (10.8 billion dollar annual turnover and 400,000 personnel) and in Japan, Matsushita (4.9 billion dollar annual turnover and 83,000 workers). Tens of the 15 leading multinational corporations are based in the United States. One more circumstance is noteworthy in this connection. The same multinationals are the leading contractors in the military and industrial complex, actually an integral part of it. Hence, they are directly involved in the business of war.

This clearly shows the link between the mass media of capitalism and big business in general and, in particular, its most reactionary wing, the military and industrial complex.

What kind of "freedom of the press" can exist in a world in which the owners of newspapers and magazines continually dismiss editors and journalists whose political views differ from theirs and persecute reporters who dare expose the acts of those in power or in which foreign correspondents are killed on the territory of a state of "the free world," as was recently the case with Dutch journalists in El Salvador. Incidentally, "the free world" includes racist South Africa and South Korea, where practically all progressive journalists have been thrown behind bars.

Lenin's description of "freedom of the press" in the capitalist world is as topical today as ever: "...this freedom is a decption while...capitalist rule over the press remains.... In capitalist usage, freedom of the press means freedom of the rich to bribe the press, freedom to use their wealth to shape and fabricate so-called public opinion." (Lenin, Complete Collection of Works, English Edition, Moscow, Progress Publishers, Vol 28, p 461).

The expression "information imperialism" is now used throughout the world. It reflects the abnormal situation which has resulted from present-day imperialist policy and practice.

In the nonsocialist part of the world, a handful of corporations controls approximately 80 percent of daily papers, 90 percent of short-wave radio stations and 95 percent of TV networks. As much as 80 percent of the information disseminated by the capitalist countries through the mass media has been supplied by the four leading telegraph agencies of the West--the Associated Press and the United Press International of the United States, REUTERS of Great Britain, and FRANCE PRESSE. They transmit about 40 million words a day to 110 countries. All this is done to the accompaniment of fine words about the "free flow of information."

A huge machinery of foreign-policy propaganda has been established through government lines, too. Dozens of government institutions deal with this in the United States, for example. The most prominent of them, the U.S. Information Agency (USIA) has about 200 centres in 126 countries. It issues scores of newspapers and magazines and prepares hundreds of radio and television programmes for other countries. The USIA staff numbers approximately 8,000 people and its budget has peaked at 640 million dollars this year. The Pentagon also

possesses a wide propaganda apparatus. On the whole, the U.S. Government annually spends 2,500 million dollars on propaganda.

Radio broadcasting is considered the main channel of U.S. foreign-policy propaganda. "The Voice of America," "Liberty" and "Radio Free Europe," government-controlled radio stations, beam their programmes in more than 40 languages about 2,000 hours a week.

Similar government propaganda services exist in England (the British Council and BBC Radio), Federal Germany (Goethe Institute, Deutsche Welle and Deutschlandfunk) and France (Alliance Francaise and France-Inter). Their activities are coordinated by NATO Headquarters.

Thus, the capitalist state of our day has combined its efforts with private monopoly capital to establish a special machinery of foreign-policy propaganda. This once again shows that the ruling classes of the capitalist countries attach great significance to ideological struggle.

While carrying out the orders of monopolies and governments, this giant propaganda machinery achieves several aims at once on the international scene.

Its goal regarding socialist countries is to try to undermine their unity, to weaken their international position, to instill bourgeois ideology in their populations through subversive activities and psychological warfare, and to establish imperialist diktat over the world of socialism.

Its goal regarding the developing countries is to try to keep them within the capitalist sphere of influence, to prevent progressive social reforms in Asia, Africa and Latin America and to vindicate the most merciless exploitation of these nations by Western corporations.

Its goal regarding the world public is to try to propagandize the masses of people in the spirit of anticommunism, to try to vindicate the arms race by an imaginary "Soviet military threat" and the quell the antiwar movement.

How does the imperialist propaganda machine try to attain these goals?

Without going deep into history, it is best to discuss the propaganda situation developing around the most important problem of our day, that of war and peace.

The question arises, however: is this vitally important problem properly tackled in the reports of Western telegraph agencies, TV companies and radio stations which dominate the "information market" of the capitalist and the developing countries? An unbiased analysis has shown that the subject of war and peace has been misrepresented, even falsified. Following the example of U.S. politicians and military leaders, views on the possibility of "local" or "limited" nuclear war and about "the advantages of neutron weapons killing people while preserving material wealth," the "inadequate" stockpiles of nuclear bombs, etc, are being widely popularized. Thousands of papers and radio

stations in Western countries have even gone to such lengths as to propagate the statement made by Alexander Haig, ex-U.S. secretary of state, that there are things more important than peace.

Turning the truth inside out, the United States and other NATO countries have launched a propaganda campaign against the Soviet Union, accusing it of causing the arms race. Apparently, they have "forgotten" that the USSR has advanced more than 100 concrete proposals on disarmament and that none other than the United States has blocked the adoption of the majority of them. At the 36th UN General Assembly alone, the United States voted approximately 50 times against the proposals of other countries on international security and disarmament. On more than one occasion, only Israel sided with the United States. The Western press does not inform its readers about this. It continues to spread lies about an imaginary "Soviet threat."

The USSR passed a law banning war propaganda in 1951. Meanwhile, the NEW YORK TIMES points out that the American idea of "freedom of the press" implies a complete freedom of expression for...the supporters of war.

Let us also tackle the situation in the Middle East. Most states of the world have recognized the legitimate rights of the Palestine people and their sole representative, the Palestine Liberation Organisation. The UN has passed resolutions on this. Meanwhile, a considerable number of U.S. propaganda agencies to this day deny the existence of Palestinians' rights, depicting their people as "terrorists" and practically supporting the policy of genocide, pursued by Israel.

In connection with the Middle-East problem, mention should be made of extremely hostile Zionist propaganda and its agents.

Today more and more people are coming to realize the significant role of information in international affairs. No wonder these problems are ever more often raised in international negotiations in the United Nations, UNESCO and the movement of nonalignment. The developing countries demand that a new international information order be established, which would give them the opportunity to tell the world about themselves and their policy. This legitimate demand has been vigorously supported by the Soviet Union and other socialist countries. The self-same U.S. and West European monopolies and governments, as always, resist it.

With the consolidation of ultra-reactionaries in the mass media, anticommunist propaganda assumes increasingly wider scope.

The current further monopolization of the mass media in the world of capitalism, and its joining with the military and industrial complex, the expansion of the psychological war against the socialist countries and the attempts to vindicate the preparations for another world war, harm the cause of peace and evoke anxiety. That is why the Warsaw Treaty member-countries have considered it especially necessary to touch on this problem in the Political Declaration of the Political Consultative Committee, issued last January in Prague. The declaration emphatically denounces the use of the mass media for the aggravation

of tensions, the vindication of the arms race, the interference into the internal affairs of other countries and slander against the world of socialism. This was stated at the Conference of the Secretaries on International and Ideological Affairs of the Central Committee of the Parties of Fraternal Countries, held in Moscow last March.

The present-day ideological and propaganda activization of the monopolies and governments of Western countries is not an "attack" but essentially a psychological counterattack, caused by the weakening of the general ideological and political position of imperialism in the world. Communist ideology steadily becomes the most powerful and attractive force in the spiritual life of humanity. This objective process cannot be checked either by the ideological machinery of state and monopoly capitalism or by its falsifying labels.

(AGITATOR No 16, 1983, Abridged)

CSO: 5500/1034

INTERMODULATION CHARACTERISTICS OF TVBS SATELLITE RECEIVERS

Milan ALTA FREQUENZA in English Mar-Apr 83 pp 118-125

[Article by Franco Mussino]

[Text]

Abstract. The receiving station of the future broadcast satellite system in the 12GHz band should be able to accept many signals of different origin and level. Primary signals will be from the national satellite system, while others will be received due to the unavoidable overspill of the satellite signals of the neighbouring countries.
All signals are amplified in the broadband SHF receiver of preferably 800MHz bandwidth. The receiver non-linearity together with the regular channel spacing, may produce critical intermodulation products, which become of practical concern when comparatively low level signals are amplified together with high level signals.
This paper introduces the intermodulation problem in a general form and continues then with a review of 14 selected receiving locations in Europe. The investigation leads to certain recommendations for the receiver linearity with distinction being made between individual and community reception.

1. INTRODUCTION

The WARC-BS 77 (World Administrative Radio Conference on Broadcasting Satellite held in Geneva in 1977) has planned the 12 GHz frequency band (11,7 - 12,5 GHz), 800 MHz wide, such that up to 40 TV channels frequency modulated can be transmitted from any orbit position on alternate circular polarizations (left-hand and right-hand); this avoids interferences due to a channel spacing (19.18 MHz) lower than the channel bandwidth (27 MHz). Overspill (wideband) reception can lead to the receiver input up to 20 channels (with a spacing of 38.36 MHz) on one polarization. The relative signal levels depend on the receiver location and some 15 dB variation between maximum and minimum level may be experienced in critical cases.

Because of the regular channel spacing in the band, many of the 3rd order intermodulation products will fall into the wanted channels and an appropriate receiver linearity requirement will therefore have to be imposed on any broadband receiver. A bandwidth limitation of the SHF and 1st IF parts of the receiver to 400 MHz (sufficient for the national channels only) will reduce the number of intermodulation products considerably, but is not believed to be practical as it would constrain the receiving possibilities.

After considering the intermodulation behaviour of the TVBS receiver from a general point of view, this paper reviews 14 selected receiving points throughout Europe. It than suggests a generally applicable design requirement for the receiver linearity, with distinction being made between individual and community receivers.

2. RECEIVING CONDITIONS

Taking into account that the 5 channels assigned to each European Country can be considered at the same level, the intermodulation requirements of the receiver depend mainly on the receiving conditions, which can be optimized considering only the national channels (individual receiver) or the weakest channels (community receiver).

In the first case (individual receiver), the most critical conditions, from the intermodulation point of view, is the presence of 20 channels with the same level at the SHF receiver input. This may happen, for example, in Belgium (for right-hand polarized channels) or in Switzerland (for left-hand polarized channels).

In the second case (community receiver) the most critical condition is the reception of 15 weak channels in the presence of 5 strong national channels. This may happen, for example, in the South of France (for right-hand polarized channels) or in the South of Italy (for left-hand polarized channels).

Particular receiving conditions will be examined in para.5.

3. GENERAL INTERMODULATION PRODUCT ANALYSIS

When the signal bandwidth is lower than an octave, the second-order products and the third-order harmonics are always out-of-band. Higher order products are here considered as negligible.

In the case of TVBS, the bandwidth at 12 GHz is 800 MHz, which is far less than an octave. The 1st IF band is usually selected between 0.95 GHz and 1.75 GHz; this allocation can avoid the generation of second order products in this band.

Assuming that the output signal of the non-linear part of the TVBS receiver can be expressed by the formula:

(1) $$V_u = k_1 V_i + k_2 V_i^2 + k_3 V_i^3$$

and the input signal is:

(2) $$V_i = A \cos 2\pi f_a t + B \cos 2\pi f_b t + C \cos 2\pi f_c t$$

the third-order products that fall within the wanted band are of the type:

$f_a + f_b - f_c$ with a level of: $3/2\, k_3\, ABC$

$2f_a - f_b$ with a level of: $3/4\, k_3\, A^2B$

where A, B, C are the input signal levels and K_3 is the third-order distortion coefficient of the input signals producing the intermodulation products.

The level of any intermodulation product is dependent upon the levels of the mixing input signals; it should also be noted that the products

of the type $2f_a - f_b$ are 2 times (6 dB) lower than the triple-beat intermodulation products of the type $f_a + f_b - f_c$.

Considering two group of channels with a level difference of x dB, some intermodulation products will have a level which is x dB, 2 x dB, 3 x dB, x + 6 dB, 2 x + 6 dB, 3x + 6 dB lower than the triple-beat products originated by the highest level signals.

The intermodulation products will be further spread in frequency, but this is not expected to lead to a significant improvement in the carrier-to-interference ratio because the subjective (noise-like) effect depends on the istantaneous frequency of beats. Therefore, the overall effect of the intermodulation products, falling in a given channel, shall be evaluated adding the various intermodulation components on a power basis.

Taking into account the above considerations, a computer program has been written for calculating the number and the relative levels of the intermodulation products for the following cases:

a) 20 channels at the same level (favourable overspill); the results of the calculations are indicated in Table 1

b) channels at the maximum level in one half-band and 10 channels at a lower level of x dB in the other half-band (typical overspill: first case); the results of the calculations, when the channels at the maximum level are in the upper half-band and the lower level channels are in the lower half-band are indicated in Table 2; similar results can be obtained exchanging the two half-bands

c) 10 channels at the maximum level distributed equally across the band and the other 10 channels, also equally distributed across the band, but at a lower level of x dB; (typical overspill: second case); the results of the calculations are indicated in Table 3.

d) 5 channels at the maximum level and 15 channels at a lower level of x dB (unfavourable overspill); the results of the calculations are indicated in Table 4.

4. EVALUATION OF THE CARRIER-TO-INTERMODULATION PRODUCTS REQUIREMENTS AND INTERCEPT POINT LEVELS

The investigation of the intermodulation characteristics of the TVBS receiver and the results of the calculations obtained in some significative cases (see Tables1, 2, 3 and 4) lead to the assesment of the intermodulation requirements of the TVBS receiver.

4.1 Overall carrier-to-intermodulation products ratio (protection ratio)

Considering the intermodulation products as noise-like, a reasonable assumption could be to allocate 10% of the overall permissible noise contribution to this source; in this case, the total interfering level, due to the intermodulation pro-

TABLE 1

Number of intermodulation products falling in each channel considering:
20 channels (right-hand or left-hand circular polarization) at the same level

Circular polarization				Number of intermodulation products		
right-hand		left-hand		of type $f_a+f_b+f_c$ (0 dB)	of type $2f_a-f_b$ (-6dB)	Total (weighted)
Country	Channel	Country	Channel			
F	1	D	2	81	9	83.25
L	3	A	4	90	9	92.25
F	5	D	6	98	9	100.25
L	7	A	8	105	9	107.25
F	9	D	10	111	9	113.25
L	11	A	12	116	9	118.25
F	13	D	14	120	9	122.25
L	15	A	16	123	9	125.25
F	17	D	18	125	9	127.25
L	19	A	20	126	9	128.25
B	21	CH	22	126	9	128.25
NL	23	I	24	125	9	127.25
B	25	CH	26	123	9	125.25
NL	27	I	28	120	9	122.25
B	29	CH	30	116	9	118.25
NL	31	I	32	111	9	113.25
B	33	CH	34	105	9	107.25
NL	35	I	36	98	9	100.25
B	37	CH	38	90	9	92.25
NL	39	I	40	81	9	83.25

ducts, must remain at least 24 dB below the wanted signal level (10 dB less than the minimum carrier-to-noise ratio of 14 dB as assumed at WARC-BS 77). While this might lead to acceptable picture quality for overspill reception, it is not considered adaquate for a practical design value.

Alternatively and more conservatively, the intermodulation products are considered as co-channel interference; in this case, the additional interference contribution due to the intermodulation products must remain well below the overall 30 dB requirement for co-channel interferences. This requirement, the apportionment of the link tolerances and the assumption of an adeguate margin, suggest a protection ratio (P) of 33 dB for the receiving side only.

4.2 Individual receiver analysis

Considering the TVBS receiver optimized for the national channel reception, the worst working

TABLE 2

Number of intermodulation products falling in each channel considering:
10 channels at the maximum level and 10 channels at a level of -x dB

Circular polarization						Number of intermodulation products							
Right-hand			Left-hand			of type: $f_a+f_b-f_c$				of type: $2f_a-f_b$			
Country	Channel relative level		Country	Channel relative level		relative level				relative level			
	(0 dB)	(-x dB)		(0 dB)	(-x dB)	(0) dB	(-x) dB	(-2x) dB	(-3x) dB	(-6) dB	(-6 -x) dB	(-6 -2x) dB	(-6 -3x) dB
F		1	D		2		45	20	16			5	4
L		3	A		4		53	17	20	1		4	4
F		5	D		6	1	59	15	23	1		4	4
L		7	A		8	2	63	15	25	2		3	4
F		9	D		10	4	65	16	26	2		3	4
L		11	A		12	6	65	19	26	3		2	4
F		13	D		14	9	63	23	25	3		2	4
L		15	A		16	12	59	29	23	4		1	4
F		17	D		18	16	53	36	20	4		1	4
L		19	A		20	20	45	45	16	5			4
B	21		CH	22		16	45	45	20	4			5
NL	23		I	24		20	36	53	16	4	1		4
B	25		CH	26		23	29	59	12	4	1		4
NL	27		I	28		25	23	63	9	4	2		3
B	29		CH	30		26	19	65	6	4	2		3
NL	31		I	32		26	16	65	4	4	3		2
B	33		CH	34		25	15	63	2	4	3		2
NL	35		I	36		23	15	59	1	4	4		1
B	37		CH	38		20	27	53		4	4		1
NL	39		I	40		16	20	45		4	5		

condition is that of case a; the results of the calculation are given in Table 1, where the channels 19 and 21 (or 20 and 22) are interfered with by 126 intermodulation products at the maximum level (0 dB) and 9 at a level 6 dB lower; this corresponds to an equivalent total number of intermodulation products of 128.25, obtained with a weighting procedure of the intermodulation products of different levels. Therefore, the increase of the interfering power (ΔI_m), referred to a single intermodulation product, is:

(3) $\Delta I_m = 10 \log 128.25 = 21.1$ dB

On the basis of this value and of a protection ratio (P) which ensures acceptable picture quality, it is possible to define the intermodulation requirements for the TVBS receiver and in particular the intercept point (fig.1), referred to the receiver input.

TABLE 3

Number of intermodulation products falling in each channel considering:
10 channels at the maximum level and 10 channels at a livel of -x dB

Circular polarization						Number of intermodulation products							
right-hand			left-hand			of type: $f_a+f_b-f_c$				of type: $2f_a-f_b$			
Country	Channel relative level		Country	Channel relative level		relative level				relative level			
	(0 dB)	(-x dB)		(0 dB)	(-x dB)	(0) dB	(-x) dB	(-2x) dB	(-3x) dB	(-6) dB	(-6 -x) dB	(-6 -2x) dB	(-6 -3x) dB
F		1	D		2		65		16		5		4
L	3		A	4		16		74		4		5	
F		5	D		6		78		20		5		4
L	7		A	8		20		85		4		5	
F		9	D		10		88		23		5		4
L	11		A	12		23		93		4		5	
F		13	D		14		95		25		5		4
L	15		A	16		25		98		4		5	
F		17	D		18		99		26		5		4
L	19		A	20		26		100		4		5	
B		21	CH		22		100		26		5		4
NL	23		I	24		26		99		4		5	
B		25	CH		26		98		25		5		4
NL	27		I	28		25		95		4		5	
B		29	CH		30		93		23		5		4
NL	31		I	32		23		88		4		5	
B		33	CH		34		85		20		5		4
NL	35		I	36		20		78		4		5	
B		37	CH		38		74		16		5		4
NL	39		I	40		16		65		4		5	

If a protection ratio (P) of 33 dB is assumed (according to the previous considerations), the difference between the level of the wanted carrier (C) and that of each triple-beat intermodulation product (I_1) in a channel must be greater than:

(4) $C/I_1=P+\Delta I_m=33+21.1=54.1$ dB (+)

The maximum level of the received signal for each channel, using an antenna of 0.9 m diameter, is about -72 dBm.

As shown in fig.1, the level of each 3rd order intermodulation product (I_1) grows by 3 dB for a 1 dB increase of the input signal levels (L_i); consequently the C/I_1 ratio decreases by 2 dB. Assuming that all the 20 channels are occupied by signals

(+) This value should be increased of 6 dB, if the intermodulation products of the type $2f_a-f_b$ are considered.

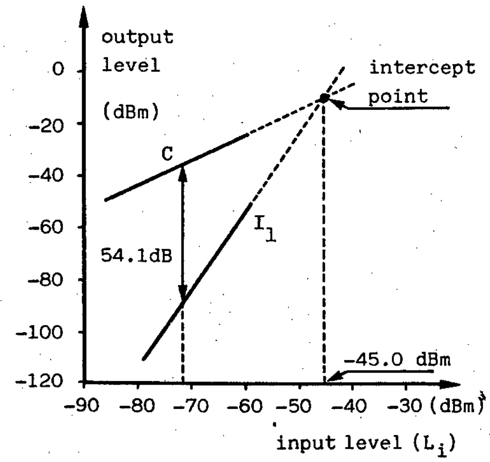


Fig.1 - Output level of the SHF receiver (whose gain is assumed as 35 dB) for the carrier (C) and a single triple-beat intermodulation product (I_1), versus the input level (L_i) of each channel.

at L_i=-72 dBm and taking into account the above considerations, the intercept point (IP), referred to the input signal level, can be calculated using the following formula:

$$(5)\quad IP=L_i+\frac{C/I_1}{2} = -72 + \frac{54.1}{2} = -45.0 \text{ dBm}$$

4.3 *Community receiver analysis*

Considering the TVBS receiver optimized for the weakest channel reception, the working conditions of cases b, c and d can be applied, in which the 20 channels are occupied by signals at different levels.

Tables 2,3 and 4 show the results obtained for these cases.

The total equivalent number of the intermodulation products for each channel, taking into account the levels of the intermodulation products falling in a given channel, referred to the level of the unmodulated carrier of that channel, has been first calculated.

Then, the required intercept point, for the channel operating in the worst conditions has been calculated for each value of the difference (x) between the levels of the strongest and of the weakest channels.

Finally, the difference (Δ(IP)) between the value of IP derived from the cases shown in Tables 2, 3 and 4 and the value of IP derived considering 20 channels at the same minimum level (Table 1), has been calculated; the results are given in Table 5 and in fig.2, versus the x values.

TABLE 4

Number of intermodulation products falling in each channel considering:
5 channels at the maximum level and 15 channels at a level of -x dB

Circular polarization						Number of intermodulation products							
right-hand			left-band			of type: $f_a+f_b-f_c$				of type: $2f_a-f_b$			
Country	Channel relative level (0 dB)	(-x dB)	Country	Channel relative level (0 dB)	(-x dB)	relative level (0) dB	(-x) dB	(-2x) dB	(-3x) dB	relative level (-6) dB	(-6 -x) dB	(-6 -2x) dB	(-6 -3x) dB
F		1	D		2		10	35	36				9
L		3	A		4		10	39	41			5	4
F		5	D		6		14	40	44				9
L		7	A		8		13	44	48	1		4	4
F		9	D		10		17	44	50		1		8
L		11	A		12	1	14	49	52	1		4	4
F		13	D		14		20	47	53		1		8
L		15	A		16	2	13	55	53	2		3	4
F		17	D		18		22	49	54		2		7
L		19	A		20	4	10	61	51	2		3	4
B		21	CH		22		24	50	52		2		7
NL	23		I	24		2	10	54	59	2		2	5
B		25	CH		26		25	50	48		3		6
NL	27		I	28		4	6	57	53	1	1	3	4
B		29	CH		30		25	49	42		3		6
NL	31		I	32		4	4	57	46	2	1	2	4
B		33	CH		34		23	47	35		4		5
NL	35		I	36		4	3	52	39	1	2	3	3
B		37	CH		38		20	44	26		4		5
NL	39		I	40		2	4	44	31	2	2	2	3

4.4 Requirements

The intermodulazion requirements here discussed are related to the broadband parts of the TVBS receiver, which are:

- the SHF receiver, where the 12 GHz signal is converted to the 1st IF (0.95 - 1.75 GHz)
- the distribution network, where very few amplifiers in cascade (individual receiver) or several amplifiers in cascade (community receiver) can be found.

The channel selection is performed in a third part of the TVBS receiver, the indoor unit, which can be placed near to the TV set or, in the future, integrated in the TV set itself.

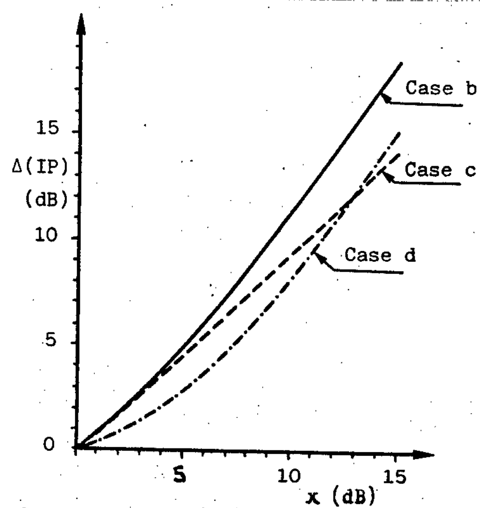


Fig.2 - Increment Δ(IP) of the intercept point level required to maintain a protection ratio of 33 dB for the weakest signals (with respect to the case where all channels are at the same level of the weakest signals), versus the diffence (x) between the maximum and minimum channel levels.

Case b : typical overspill (first case)
Case c : typical overspill (second case)
Case d : unfavourable overspill

TABLE 5

Results of calculation of Δ(IP)values, versus x values

x (dB)	Δ(IP) (dB)		
	Case b (Table 2)	Case c (Table 3)	Case d (Table 4)
1	0.82	0.82	0.41
2	1.74	1.71	0.89
3	2.75	2.63	1.46
4	3.84	3.58	2.13
5	5.00	4.54	2.91
6	6.22	5.52	3.81
7	7.50	6.51	4.82
8	8.81	7.50	5.93
9	10.17	8.50	7.14
10	11.55	9.49	8.41
11	12.96	10.49	9.74
12	14.39	11.49	11.12
13	15.83	12.49	12.52
14	17.28	13.49	13.95
15	18.74	14.49	15.40

TABLE 6

Received power flux level (PFL) and TVBS receiver input level (L_1) obtained with a dish antenna of diameter D

Receiving place / Satellite	Paris PFL dB (W/m²)	Paris L_i (dBm)	Lyon PFL dB (W/m²)	Lyon L_i (dBm)	Toulouse PFL dB (W/m²)	Toulouse L_i (dBm)	Luxemburg PFL dB (W/m²)	Luxemburg L_i (dBm)	Bruxelles PFL dB (W/m²)	Bruxelles L_i (dBm)	The Hague PFL dB (W/m²)	The Hague L_i (dBm)	Bonn PFL dB (W/m²)	Bonn L_i (dBm)
		D=0.9m		D=1.8m		D=2.1m		D=0.9m		D=0.9m		D=0.9m		D=0.9m
France	-100	-73.8	- 98	-65.8	-100	-66.5	-102	-75.8	-103	-76.8	-104	-77.8	-103	-76.8
Luxemburg	-105	-78.8	-107	-74.8	-115	-81.5	- 98	-71.8	-105	-78.8	-107	-80.8	-100	-73.8
Belgium	-100	-73.8	-109	-76.8	-115	-81.5	-100	-73.8	- 98	-71.8	-100	-73.8	-100	-73.8
Netherlands	-103	-76.8	-113	-80.8	-125	-91.5	-103	-76.8	-100	-73.8	- 98	-71.8	-101	-74.8
		D=1.8m		D=1.8m		D=2.1m		D=0.9m		D=1.8m		D=1.8m		D=0.9m
Germany	-103	-70.8	-103	-70.8	-111	-77.5	-100	-73.8	-101	-68.8	-101	-68.8	-100	-73.8
Austria	-111	-78.8	-105	-72.8	-115	-81.5	-107	-80.8	-111	-78.8	-112	-79.8	-107	-80.8
Switzerland	-105	-72.8	-100	-67.8	-107	-73.5	-105	-78.8	-110	-77.8	-112	-79.8	-107	-80.8
Italy	-107	-74.8	-103	-70.8	-111	-77.5	-105	-78.8	-107	-74.8	-109	-76.8	-105	-78.8

Receiving place / Satellite	Hamburg PFL dB (W/m²)	Hamburg L_i (dBm)	Munich PFL dB (W/m²)	Munich L_i (dBm)	Wien PFL dB (W/m²)	Wien L_i (dBm)	Bern PFL dB (W/m²)	Bern L_i (dBm)	Rome PFL dB (W/m²)	Rome L_i (dBm)	Milan PFL dB (W/m²)	Milan L_i (dBm)	Naples PFL dB (W/m²)	Naples L_i (dBm)
		D=1.8m		D=3.0m		D=0.9m		D=1.8m		D=2.1m		D=0.9m		D=3.0m
France	-108	-75.8	-103	-66.4	-107	-80.8	-100	-67.8	-103	-69.5	-110	-73.8	-103	-66.4
Luxemburg	-107	-74.8	-117	-80.4	-125	-102.8	-107	-74.8	-130	-96.5	-120	-93.8	-135	-98.4
Belgium	-105	-72.8	-115	-78.4	-125	-102.8	-109	-76.8	-130	-96.5	-118	-91.8	-135	-98.4
Netherlands	-102	-69.8	-116	-79.4	-125	-102.8	-112	-79.8	-130	-96.5	-120	-93.8	-135	-98.4
		D=1.8m		D=0.9m		D=0.9m		D=0.9m		D=2.1m		D=0.9m		D=3.0m
Germany	-100	-67.8	- 98	-71.8	-102	-75.8	-100	-73.8	-107	-73.5	-100	-73.8	-111	-74.4
Austria	-113	-80.8	- 98	-71.8	-100	-73.8	-100	-73.8	-111	-77.5	-100	-73.8	-116	-79.4
Switzerland	-113	-80.8	-100	-73.8	-107	-80.8	- 98	-71.8	-115	-81.5	-100	-73.8	-120	-83.4
Italy	-107	-74.8	-100	-73.8	-102	-75.8	-102	-75.8	- 98	-64.5	-100	-73.8	-100	-63.4

4.4.1 SHF receiver

The above calculations can lead to the conclusion that an intercept point of about -45 dBm, referred to the input signal level, is adeguate for an individual receiver, using an antenna diameter of about 0.9 m ($L_i \leq -72$ dBm).

For a community receiver, designed for weak signal reception using an antenna with a large diameter (up to 3 m), but strong national signals are also present ($L_i \leq -62$ dBm), an intercept point about 10 dB higher than that calculated for the individual receiver is desirable; therefore, an intercept point, referred to the input signal level, of about - 35 dBm is suggested.

4.4.2 Distribution network

If the TVBS receiver has several non-linear amplifiers in cascade, distributing the output signal (at the 1st IF) of the SHF receiver, an increase of the protection margin will be needed.

Assuming that the contribution of both the SHF receiver and the distribution network to the intermodulation products level is of the same amount, the protection ratio (P = 33 dB) considered above, should be increased of 3 dB.

This means that the intercept point level of the SHF receiver should be 1.5 dB higher than the values derived above.

TABLE 7

Results of calculation of IP values, versus x values for 14 selected receiving places

Receiving place	Polarization	Antenna diameter D (m)	Maximum input level (dBm)	Minimum input level (dBm)	x (dB)	Δ(IP) (dB)	IP (dBm)
Paris	1	0.9	-73.8	-78.8	5	5.2	-46.6
	2	1.8	-70.8	-78.8	8	7.9	-43.8
Lyon	1	1.8	-65.8	-80.8	15	13.8	-39.9
	2	1.8	-67.8	-72.8	5	4.1	-41.6
Toulouse	1	2.1	-66.5	-91.5	25	25.4	-39.0
	2	2.1	-73.5	-81.5	8	7.4	-47.0
Luxemburg	1	0.9	-71.8	-76.8	5	4.1	-45.7
	2	0.9	-73.8	-80.8	7	5.2	-48.6
Bruxelles	1	0.9	-71.8	-78.8	7	6.9	-44.8
	2	1.8	-68.8	-78.8	10	8.4	-43.4
The Hague	1	0.9	-71.8	-80.8	9	9.3	-44.5
	2	1.8	-68.8	-79.8	11	9.9	-42.8
Bonn	1	0.9	-73.8	-76.8	3	3.4	-46.4
	2	0.9	-73.8	-80.8	7	5.1	-48.7
Hamburg	1	1.8	-69.8	-75.8	6	4.7	-44.0
	2	1.8	-67.8	-80.8	13	12.8	-40.9
Munich	1	3.0	-66.4	-80.4	14	13.1	-40.2
	2	0.9	-71.8	-73.8	2	1.7	-45.0
Wien	1	0.9	-80.8	-102.8	22	-	-61.0 (+)
	2	0.9	-73.8	-80.8	7	7.5	-46.2
Bern	1	1.8	-67.8	-79.8	12	10.6	-42.1
	2	0.9	-71.8	-75.8	4	3.5	-45.2
Rome	1	2.1	-69.5	-96.5	27	-	-49.7 (+)
	2	2.1	-64.5	-81.5	17	16.6	-37.8
Milan	1	0.9	-73.8	-93.8	20	-	-54.0 (+)
	2	0.9	-73.8	-73.8	0	0.0	-46.8
Naples	1	3.0	-66.4	-98.4	32	-	-46.6 (+)
	2	3.0	-63.4	-83.4	20	20.9	-35.5

Note: The IP levels have been calculated to maintain a protection ratio of 33 dB for the most unfavourable channel.
In some cases (marked (+)), where the weakest signals are unusable (levels lower than -80 dBm) and only the strongest signals are of interest (C/N ratio higher than 14 dB), the intercept point has been calculated taking into account the total interfering power on the strongest channels, following the procedure described in par. 4.2.

Considering the distribution network, where n amplifiers in cascade operate at about the same input level, the level of each intermodulation products due to a single amplifier should be 10 log n (dB) lower than the required overall value.

Assuming that:

- the input level of the distribution amplifiers is not higher than -40 dBm
- the intercept point level is 27 dB higher than the maximum input signal level (as calculated above)
- up to 20 amplifiers in cascade can be used
- an increase of the protection ratio of 3 dB (as previously discussed) is needed,

the intercept point, referred to the input signal level, for each distribution amplifier can be derived:

$$\text{(6)} \qquad IP = -40 + 27 + \frac{10 \log 20 + 3}{2} = -5 \text{ dBm}$$

5) CASE STUDIES

The previous calculations of the intermodulation requirements for the TVBS receiver can be applied to some practical receiving conditions, in order to support the above more general investigation.

Receiver locations have been considered in 14 selected places throughout Europe, served from national satellites at 19° W.

The power flux level (PFL) values for each national group of channels are indicated in Table 6; these are approximate and derived from calculations using the assumptions of the WARC-BS 77 plan. No allowance has been made for atmospheric attenuation; the signal levels (L_i) and the corresponding antenna dish diameters (D) are also indicated in Table 6. (++)

Considering the above input signal levels, the corresponding Δ(IP) and IP values have been calculated (Table 7). In some cases different antenna diameters have been considered for channels having different polarization; the smaller antenna diameter is for individual or community reception with favourable overspill conditions; the largest antenna diameter is for community reception in unfavourable overspill conditions. If the largest antenna diameter is used for both polarizations, care should be taken to avoid overloading of the SHF receiver handling the highest level (national) channels.

The required value of the intercept point (IP) for each receiving location can be derived adding the value of Δ(IP) to the value of IP calculated considering 20 channels at the same level $L_{i(min)}$:

$$\text{(7)} \qquad IP = \Delta(IP) + L_{1(min)} + \frac{C/I_1}{2}$$

where $C/I_1 = 54.1$ dB, considering the triple-beat intermodulation products.

The above calculation leads to a maximum value of the intercept point, referred to the input signal level, that is (Table 7):

- 45 dBm for an individual receiver, using an antenna diameter of about 0.9 m;
- 35 dBm for a community receiver, using an antenna diameter of less than 3m;

These values are consistent with those derived in paragraph 4.

If a distribution network with several amplifiers in cascade is used, the above values should be increased of 1.5 dB.
The intercept point for each distribution amplifier, operating with an input signal level not higher than -40 dBm, should be not lower than -5 dBm, if referred to the input signal level, as calculated in paragraph 4.

Table 8 shows the required intercept point (IP) levels for the SHF receiver and the distribution amplifiers.

(++) L_i values below -80 dBm are not practicable, because they imply a C/N ratio lower than 14 dB, assumed in the WARC-BS 77 plan as a minimum value for an acceptable picture quality.

TABLE 8

Relevant characteristics of the SHF receiver and the distribution amplifiers

Characteristics / TVBS receiver parts	Maximum input level (dBm)	Protection ratio (dB)	Intercept point level (referred to the input) IP (dBm)
SHF receiver for individual reception	- 72	33 (36)	-45 (-43.5)
SHF receiver for community reception	- 62	33 (36)	-35 (-33.5)
Distribution amplifiers	- 40	36	-5

Note: The values indicated in parentheses apply when the SHF receiver is followed by a distribution network with several amplifiers in cascade.
The intercept point level for the distribution amplifiers have been calculated considering 20 amplifiers in cascade.
The intercept point levels have been derived considering the triple-beat intermodulation products. If only two input signal are considered, the above values should be increased of 3 dB.

6) CONCLUSIONS

The analysis of the intermodulation behaviours of the TVBS receiver, taking into account some typical reception conditions, has led to the calculation of the intercept point levels. The complexity of the various intermodulation products led to the development of a computer programme. The values derived both from general considerations and for 14 selected receiving places, are easily obtainable with receivers developed using the components available today on the market.

Acknowledgements

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TELE-X NORDIC TELECOMMUNICATIONS PROJECT BACKGROUND, UPDATE

Farsta TELE in English Vol XXXV, No 1, 1983 pp 45-54

[Article by Axel-Werner Wolff]

[Text]

Background

On behalf of the Nordic Council of Ministers, the question of distributing Nordic radio and television programmes by satellite has been studied since the mid-1970s. The NORDSAT project has been investigated from many different angles, including both technical and sociopolitical, and is now being studied again.

As it has been difficult to reach political agreement in the Nordic countries concerning this comprehensive operational satellite system, the idea of an experimental, less comprehensive project with an industrial policy background has been put forward in Sweden, under the name of TELE-X (Figure 1).

In 1979, the State-owned Swedish Space Corporation, together with Swedish industrial interests, started to investigate a telecommunications satellite system of this kind (Phase A). The industrial interests included SAAB-SCANIA, Telefon AB L M Ericsson and SRA Communications AB. The Swedish Telecommunications Administration was also invited to participate in the project. In November 1980, the Space Corporation and the Administration concluded an agreement on TELE-X, and this was followed by a government decision to allocate SEK 30 million for financing the definition phase of the project (Phase B). The objective of this phase was to determine the performance and price of the satellite system, to be used as a basis for a possible later decision on the implementation of the project.

The Swedish Department of Industry also invited the other Nordic countries to participate in the definition work. Finnish and Norwegian representatives have been included in various TELE-X working parties since 1981, but Denmark has decided to remain outside the project for the time being. The Swedish Broadcasting Corporation has also participated in the work.

Why a Nordic telecommunications satellite?

From the foregoing, it will be noted that the question of why a Nordic telecommunications satellite is needed is not particularly easy to answer. The intention of the TELE-X project is that industry and users in the Nordic countries should be able to acquire experience of satellite-based telecommunications systems. This would provide a valuable boost to the knowledge and experience of the telecommunications administrations and the space industries in the Nordic countries concerning space technology, satellite communications and to the ability to implement major projects in this sector. TELE-X would also provide a basis for international cooperation with Nordic participation, and improve prospects for Nordic industry to supply such systems to future markets.

This applies primarily to the earth segment (earth stations, terminals, TV receivers and subscriber equipment), although the telecommunications and electronic industries in the Nordic countries would also receive the necessary stimulus to increase their production capacity for the international telecommunications satellite market.

In summary, the project has the following main objectives:

- TELE-X is a step on the way towards increased concentration on establishing the competence of Nordic industry in the space sector.
- TELE-X will provide the means for practical investigation of the technical and economical factors associated with national/regional satellite systems.
- TELE-X will assist users, suppliers, purchasers and operators of satellite communication systems in preparing for future operational systems in the Nordic countries. Services of interest are data traffic, video services and direct broadcasting to domestic receivers.

Basic principles

To enable programmes to be received on domestic equipment, the broadcasting transponders (receiver/transmitter equipment for sound and TV) of the satellite will have to be fitted with high-power output tubes (a few hundred watts), since the aerial diameter of domestic receivers should not exceed 1 m. By using the same technology in the data/video transponders, it will be possible to communicate between small, inexpensive earth stations that can be sited by their users. In this context, small and inexpensive refers to earth stations with aerials of about 2.5 m diameter, costing in the range of SEK 300 000 -400 000. It is assumed that such earth stations could be installed on the roof of office buildings (Figure 2), thus avoiding the need for long subscriber lines.

Another basic principle is to restrict new development to items which are unavoidably specific for TELE-X. For this reason, in order to minimise technical risks, keep down costs and reduce the risk of delays, a satellite platform already developed for a French/German TV satellite project (TV SAT/TDF-1) will be used, with only limited modifications. (The platform is that part of the satellite containing the propellant, solar panels and other equipment as well as power equipment required to maintain the satellite stabilised in attitude and in orbit.) Working with France and West Germany has also provided an opportunity for Sweden to supply equipment to the French/German Eurosatellite consortium.

Organisation

As this project will cost more than one billion Swedish *Kronor* (about U.S.$ 135 million) and is technically very complicated, it has necessitated the establishment of a large organisation, even during the definition phase. See Figure 3 for further details of the organisation structure.

The experimental programme

The introduction to the TELE-X agreement between the Swedish Space Corporation and the Telecommunications Administration states that it is essential that the telecommunications experiments should be highly realistic and closely user-related. It is therefore of vital importance that the Administration should participate actively in deciding on and preparing the experiments. The agreement also points out that the telecommunications experiments would be of greater value if they were arranged so that they involved the participation of other telecommunications administrations, primarily the Nordic ones.

The Space Corporation is to have overall responsibility for the satellite project, with the Administration being responsible for the design and implementation of the teletechnical experiments. These experiments should be designed so that they are

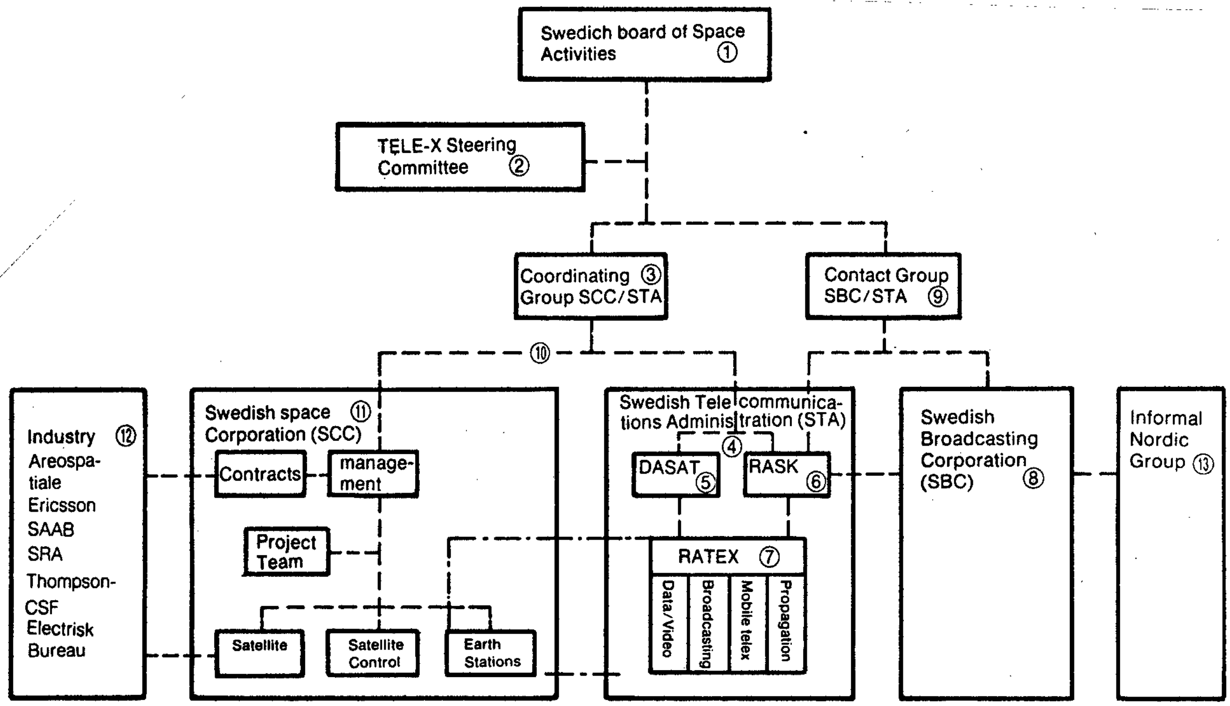


Figure 3. The organisation for the TELE-X project during the definition phase.

TELE-X: Organisation

1 Work on TELE-X is being managed by the Swedish Board of Space Activities.

2 The Board has a special Steering Committee for TELE-X, made up of members from Finland, Norway and Sweden.

3 The definition work has been split up between the parties involved: the Space Corporation, the Swedish Telecommunications Administration and industry. It is managed by a group with four members from the Space Corporation and four from the Administration.

4-7 The Administration operates two further management groups - one for the data/video experiment, DASAT (5), and one for the radio parts of the project, named RASK (6). Subordinate to the two groups is a working party, known as RATEX (7), of which those responsible for the experiments are members.

8 As far as broadcasting is concerned, contact is maintained with the Swedish Broadcasting Corporation.

9 This is effected through a group with members from the Administration and from the Broadcasting Corporation.

The Broadcasting Corporation also has a representative in RASK. Norway and Finland are represented in DASAT as well as RASK.

10 The cooperation between the Space Corporation and the Administration is based on a special agreement for TELE-X.

11 The Space Corporation has overall responsibility for the project, and is responsible for purchasing and contract negotiations with industry.

The Administration is responsible for the telecommunications experiments and the communication system. The Administration is also responsible for operating the earth stations. The personnel costs are met by the respective organisations, while the Space Corporation is responsible for other costs during the experimental period.

12 Industrial interests are involved in different ways:

- Aerospatiale is prime contractor for the satellite and is supplying the actual satellite platform (the service, propulsion and solar panel modules).
- The Ericsson Group will be the main supplier of the payload (the aerial and communication modules). Ericsson will also be prime contractor for the earth stations.
- SAAB-SCANIA will be responsible for the mechanical structure, e.g. of the aerial tower, and will also supply the satellite control system (TT&C).
- Thomson-CSF and the Norwegian Elektrisk Bureau are important sub-contractors.

13 Apart from the above organisations, the broadcasting companies of the Nordic countries are also involved, acting through an informal working party. ■

suitable for possible subsequent pre-operational applications.

The TELE-X system is structured so that it can easily be integrated into the Administration's future telecommunications network, both nationally and internationally. Under the terms of the agreement, the Swedish Telecommunications Administration shall have first refusal in taking over both the space and the earth segments after conclusion of the experimental period, if TELE-X should then continue in use on a pre-operational or operational basis.

The Administration is prepared to take over the system at a market value calculated on the basis of its traffic-handling value to the Administration.

Planned experiments

Four experiments were originally planned for the TELE-X project, i.e. data transmission, direct broadcasting of radio and TV programmes, radio wave propagation and mobile telex ("Trucksat"). While the preparatory work was in progress, several interesting video transmission applications were put forward, and a video experiment was therefore also included. As the data and video experiments are technically very similar (both involving the transmission of digital signals), they have been combined into a common data/video experiment. The mobile telex experiment and the radio wave propagation experiment have both been omitted for reasons of cost and time.

The purpose of both the data/video and the broadcasting experiments is to demonstrate the necessary technology and possible applications, and to introduce pre-operational satellite services in the Nordic countries. In particular, the data/video experiment is expected to provide valuable information on market requirements for services requiring high data transmission rates.

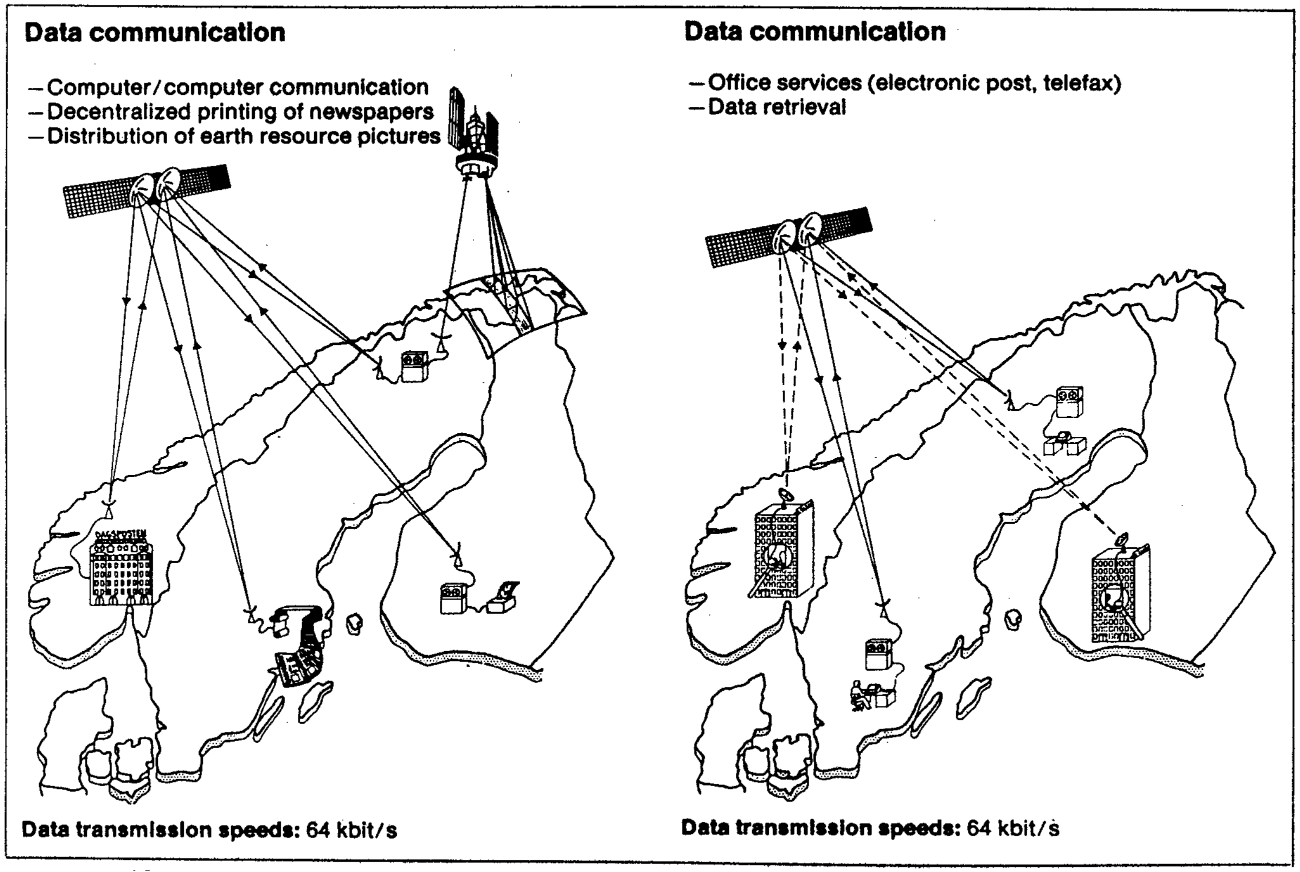
The objective of the radio wave propagation experiment was to gather data on the propagation of radio waves in the atmosphere, which would have provided a basis for the subsequent design of future communication satellites in the 20 and 30 GHz bands, and possibly also in the 40 and 90 GHz bands. However, a necessary prerequisite for including this experiment in the TELE-X project was that negotiations with the French Telecommunications Administration concerning financing had been successfully concluded, and this did not turn out to be the case.

The objective of the mobile telex experiment had been to provide a basis for the design of a system for two-way telex communication over long distances between fixed standard terminals and a large number of small mobile terminals installed in trucks, ships, buses and aircraft. A communication system of this kind was felt to be of interest to various parties, including commercial haulage companies for communication with their vehicles, often carrying valuable loads in countries with poor telecommunication facilities. The British Department of Industry was prepared to finance a transponder for this experiment, but funding was not available for integrating the transponder into the satellite platform. The thought behind this was that a mobile telex service of this kind could be operated on an international basis and, in this connection, the European Space Agency (ESA) had expressed its interest in the experiment.

Technical specifications

The technical requirements of the TELE-X system have been set out in a large number of specifications. These specifications are divided into different levels for various parts and they are being written in English, in order to facilitate international use. They are being jointly prepared by the Swedish Space Corporation, the Telecommunications Administration and industry. In the same way as described above in conjunction with the general organisational structure, the Administration is responsible for the communication system and the earth segment requirements specifications. The Space Corporation is responsible for the satellite control system require-

Figure 4. Examples of data communication via satellite.



ments and the satellite specifications.

The earth segment requirements specification describes the traffic control system, which is the key element in the data/video experiment.

The data/video experiment

The following data services may be tested by means of TELE-X:

- **Business services:**
  - internal communications within companies
  - electronic post
  - high-speed telefacsimile

- **Computer/computer communications:**
  - high-speed transmission of the contents of data bases
  - fault-tracing in computers
  - sharing of computer capacities and computer standby facilities.

- **Updating of data bases**

- **Data base searches**

- **Distribution of earth resource pictures**

- **Decentralised printing of newspapers**

Figure 4 shows some of these applications.

Possible video services via satellite are:

- **Commercial video services:**
  - TV meetings (video conferences)
  - video telephony
  - educational applications
  - telemedicine
  - conference transmissions
  - event TV (transmission to special TV cinemas)
  - video distribution, e.g. within a hotel chain
  - supervisory/security TV

- **Gathering of TV and sound radio programmes:**
  - permanent contribution
  - mobile contribution

Some of these applications are shown in Figure 5.

A Demand Assignment Multiple Access (DAMA) system, based on Single Channel per Carrier (SCPC) technology, has been chosen for the data/video experiment. This allows the traffic stations to be made simpler and therefore cheaper than they would be in a Time-Division Multiple Access (TDMA) system.

TELE-X will have a capacity of 25 one-way 2 Mbit/s channels and 500 one-way 64 kbit/s channels. As an alternative to the 2 Mbit/s channels, the satellite can carry 6 one-way 8 Mbit/s channels or 2 one-way 34 Mbit/s channels or one 140 Mbit/s channel. The 64 kbit/s channels can be replaced by 20 one-way 2 Mbit/s channels. The 2 Mbit/s rate is sufficient to transmit, for example, a black-and-white video conference, while the 8 Mbit/s rate would permit it to be transmitted in colour. 34 Mbit/s gives a picture quality equivalent to that of a domestic receiver, whereas 140 Mbit/s is suitable for the transmission of high-definition TV signals.

The transmission quality requirement is that the bit error rate must not exceed 10^{-6} for 99% of the month with the highest atmospheric attenuation due to precipitation.

Two transponders in the satellite are used for data/video transmission. One of these has a bandwidth of 86 MHz and the other a bandwidth of 40 MHz. The "wide-band" transponder is intended primarily for video signals, whereas the "narrow-band" transponder is for data signals. A third data/video transponder serves as a common switchable standby (Figure 6). The output stages of the transponders incorporate travelling wave tubes with a maximum output power of 230 W. As each earth station transmits on its own carrier and since a number of earth stations must be able to use the transponders simultaneously, it is necessary for the transponders to have extremely good linearity in order to prevent intermodulation distortion. In order to ensure this, the output power of the transponders is backed off, so that even with the maximum number of channels in operation, only about one-fifth of the output power will be used (Output Back Off).

A central data and video control

station ensures that the earth stations are assigned free channels in accordance with their requirements. The station is computerised and connects two or more traffic stations (Remote Earth Stations) as required (Figure 7). This is carried out by signalling over special 64 kbit/s channels and does not normally take more than a few seconds. The control station does not handle any traffic, but instead establishes the connections. When in full use, a control station can handle up to 5000 traffic stations. The 64 kbit/s and 2 Mbit/s links are established automatically on request from a traffic station, while the higher capacity links are booked through an operator. The data and video control station also monitors the performance of the traffic stations.

Traffic stations are of either low-speed type (64 kbit/s and 2 Mbit/s) or of high-speed type (above 2 Mbit/s). The simplest type of station - intended for 64 kbit/s data communication - is entirely solid state, and has an output power of 1 W. These stations cannot be expanded.

The high-speed stations are equipped for a maximum data speed of 34 Mbit/s, but can be modified to handle 140 Mbit/s if required, since the satellite is capable of handling signals with this speed. One of the largest stations has an output power of 600 W and is fitted with a travelling wave tube.

Most of the earth stations will be of modular design, thus reducing the development costs and permitting the stations to be expanded, if required. They will be sited on the premises of users, but it is the intention that they should be operated by the telecommunications administrations of the corresponding countries.

As far as the Nordic telecommunications administrations are concerned, it is unlikely that an automatically switched 64 kbit/s satellite network would be viable at the end of the 1980s, since by that time there should already be a terrestrial network with this capacity in use. Although an experiment with small 64 kbit/s stations, sited at the customers' premises, is of interest in the context of industrial policy, higher data transmission rates via a Nordic satellite system are of considerably more interest to the administrations.

The broadcasting experiment

The purpose of the broadcasting experiment is to broadcast radio and television signals directly to domestic receivers and to receivers for cable TV networks. Experiments will be conducted with different types of television signals and with various types of programme material. The satellite will be fitted with three transponders for broadcasting, and it must be possible to have at least two of the transponders in operation simultaneously (Figure 6). One Finnish, one Norwegian and one Swedish television channel have been selected, i.e. channels 26, 32 and 40 respectively, in accordance with the international frequency plan for satellite broadcasting (WARC-BS). This provides frequency redundancy and all three transponders can be used simultaneously, provided that only one data/video transponder is in use. The six transponders in the satellite are all of the same type, which means that each television transponder has a maximum output power of 230 W. The bandwidth is 27 MHz.

A particular problem in conjunction with the specification of data for the broadcasting experiment has been caused by the fact that there is, as yet, no international standard for modulation systems for satellite broadcasting. This is at present being considered by ITU and EBU and a decision is expected during 1983.

Great Britain has developed a system known as C-MAC, an acronym in which the C indicates the method of carrying sound and data information, while MAC (Multiplexed Analogue Components) refers to the method of carrying video information. It is probable that West Germany, the Nordic countries and France will also adopt this system, but have not yet (May 1983) reached a decision.

The sound signal in the C system is a high-speed data stream during the line blanking interval, thus permitting the bandwidth of the video signal to be increased in comparison

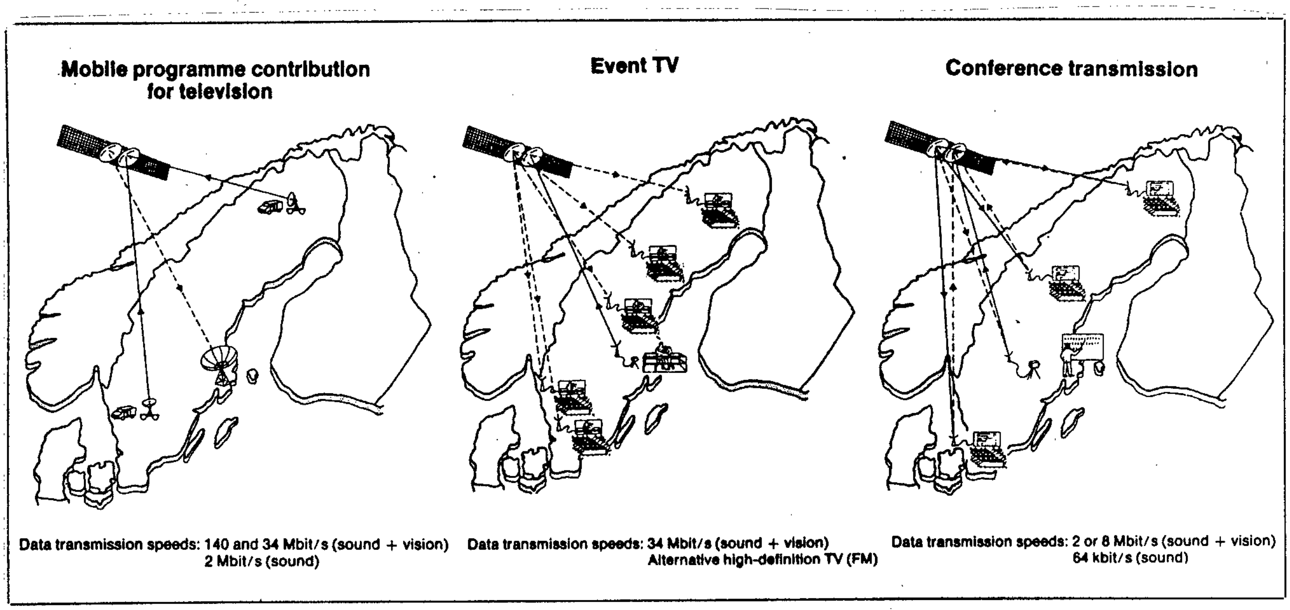
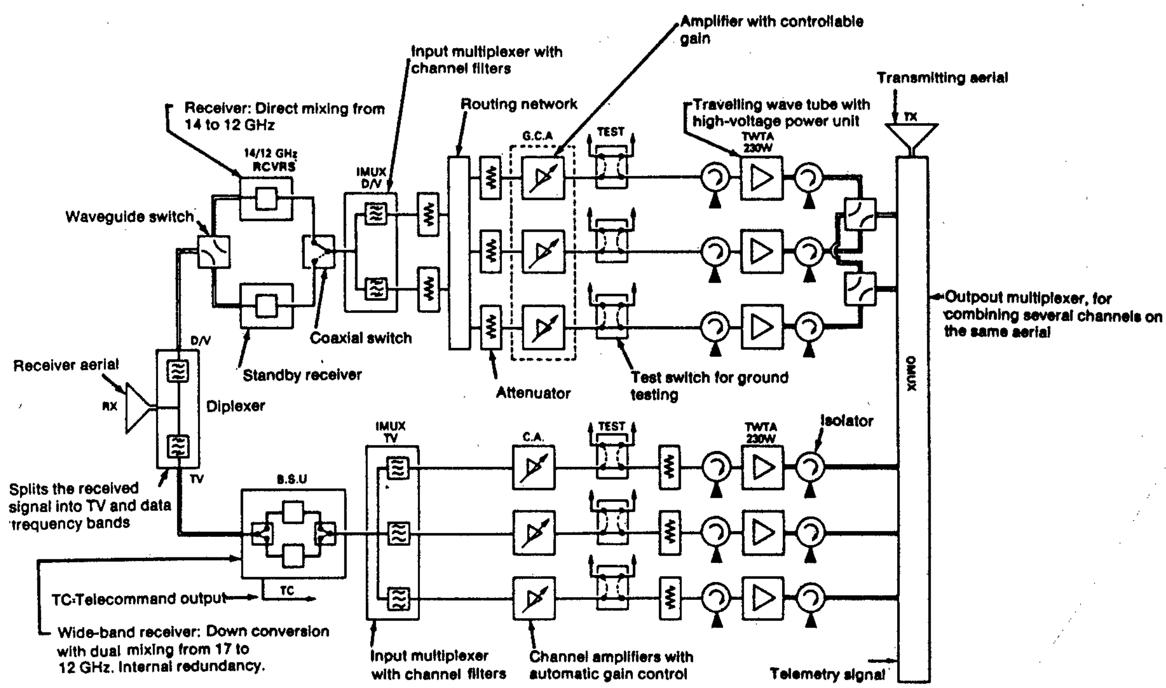


Figure 5. Examples of video transmission via satellite.

Figure 6. The repeater system in the TELE-X satellite. Source: The Swedish Space Corporation.



with systems in which the sound is carried on a sub-carrier (A4). The capacity of the C system is 7 - 8 high-quality mono channels.

The MAC system uses a time-multiplexed signal for the luminance and chrominance picture component signals. As the black-and-white and colour information are transmitted at different times, the potential interference that can occur between them in other systems, and particularly when the picture contains fine line patterns, is avoided.

The satellite can be supplied with programme material either from a common feeder link station for two or three channels or by separate, national stations, each carrying one channel. If the common feeder link station solution is chosen, it will be necessary to supplement the radio link network with additional channels. Exactly how the network would be designed depends on the type of programme transmissions with which the broadcasting companies intend to experiment.

The satellite

The satellite as shown in Figure 8 is assembled from modules. The aerial module is specific for the TELE-X satellite, and consists of an aerial tower and aerials for the experiments and for satellite control functions (Figure 9). The 14085 - 14250 MHz frequency band is used for the up-link for the data/video experiment, and the 12585-12750 MHz band for the down-link. The broadcasting experiment is carried on the 17700 - 18100 MHz and 12100 - 12500 MHz bands respectively. This makes it possible to use the same aerial system for the data/video and broadcasting experiments. As the level difference between the received and transmitted signals exceeds 100 dB, there would be a risk of interference if there were separate aerials for data/video and for broadcasting. For this reason, separate aerials are provided for reception and transmission.

In order to reduce the height of the aerial tower, Cassegrain-type aerials will be used, having a folded signal path with a sub-reflector between the feeder horn and the main reflector.

As far as the shape of the transmitting aerial is concerned, it has been necessary to compromise between the requirement for good signal strength at the edge of the service area and the Radio Regulations requirements that the power flux density in the U.S.S.R. in the 12 GHz band must be restricted. This has resulted in an elliptical aerial lobe, with a 50% value contour of 0.7° x 1.6°. The coverage area for the broadcasting experiment is shown in Figure 10, and the data/video experiment has more or less the same coverage area.

Ericsson will be main supplier for the satellite payload (the aerial and communication modules), with SAAB-SCANIA being responsible for the mechanical structure, including the aerial tower, and also for the design of the satellite control system (telemetry, tracking and command). The control system must be capable of maintaining the satellite position with an accuracy of $\pm 0.1°$ in the north/south and east/west directions. The satellite will be placed in a geostationary orbit over the equator, at a longitude of 5° east. The stabilisation system will be of the

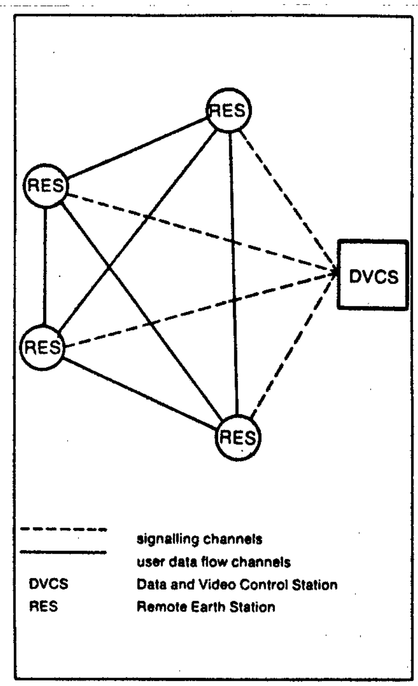


Figure 7. A sketch of the data/video network. Source: Ericsson - Elektrisk Bureau.

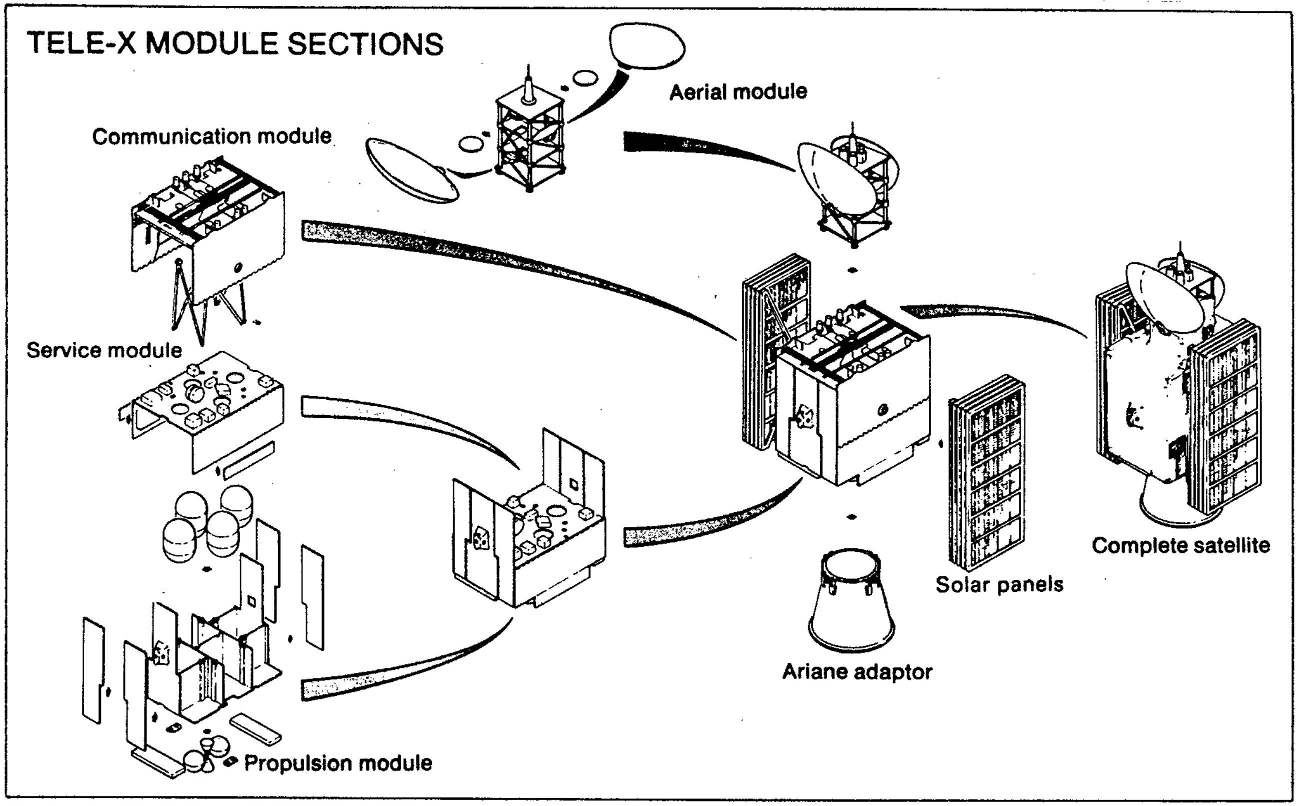


Figure 8. Modular assembly of the satellite. Platform: service module, propulsion module and solar panel module. Payload: aerial module and communication module. Source: The Swedish Space Corporation.

three-axis type and the pointing error must not exceed 0.05°.

The satellite will be 5.8 m high and 20 m wide over the fully extended solar panels (Figure 11). The mass on launching will be about 2100 kg (propellant mass of about 1000 kg) and the power generated will be 3200 W.

Milestones

The following important milestones have been passed since the definition phase was started at the beginning of 1981:

- In the spring of 1981, the Swedish Space Corporation signed a contract for definition work with Ericsson, SAAB-SCANIA and SRA.

- During the summer of 1981, the project was described to the French space corporation (CNES) and to INMARSAT.

  A special study was made of the minimum acceptable aerial size for data earth stations. In order to enable the geostationary orbit to be utilised as efficiently as possible (2 - 3° between satellite positions for homogeneous systems), the side lobes of the aerials must be suppressed with respect to the main lobe by 3 dB more than recommended by the CCIR.

- During the autumn of 1981, discussions began at departmental level concerning an agreement between the Norwegian and Swedish governments on TELE-X. These negotiations have been protracted, due to the fact that the parties have attempted to agree on an organisational structure that can also be used for any future operational satellite systems. A draft agreement was produced in November 1982.

- At the end of 1981, Swedish industry was invited to submit preliminary tenders for the space and earth segments.

- Budgetary proposals were received in the beginning of 1982. The subsequent negotiations resulted in the French company, Aerospatiale, being appointed as prime contractor for the satellite in collaboration with SAAB-SCANIA, and a binding tender was requested from the French company.

- During the spring of 1982, the Swedish government tabled its Bill No. 1981/82:175 concerning a Nordic experimental satellite system. The Bill stated that the estimated costs for TELE-X amounted to a maximum of SEK 1250 million at January 1982 price levels. This was assumed to be distributed onto Sweden, Norway and Finland in the proportions of 64%, 26% and 10% respectively, giving a cost of SEK 800 million for the Swedish share of the project. The Swedish Minister for Industry also suggested that the satellite control station should be built in Kiruna, in the far north of Sweden, in accordance with regional policy.

- During the summer of 1982, a firm proposal for the satellite was received from Eurosatellite/Aerospatiale. At the same time, the Swedish Riksdag also decided that work on TELE-X should continue in accordance with the Bill previously tabled.

- During the autumn of 1982, ITU sent out an advance publication with technical data for TELE-X. Submissions have been received from the U.S.S.R., INTELSAT, the U.S.A., EUTELSAT and France. The most serious risks of interference are with the planned EUTELSAT and French satellites for fixed services, ECS and TELECOM-1. One of the satellites in the ECS system should have a position 2° east of TELE-X, and one of the TELECOM-1 satellites is planned to be positioned 1° west of TELE-X. Coordinating negotiations have been started.

  During the autumn of 1982, a proposal was requested for the earth segment from Ericsson, in the company's capacity as prime contractor. Ericsson would work together with the Norwegian

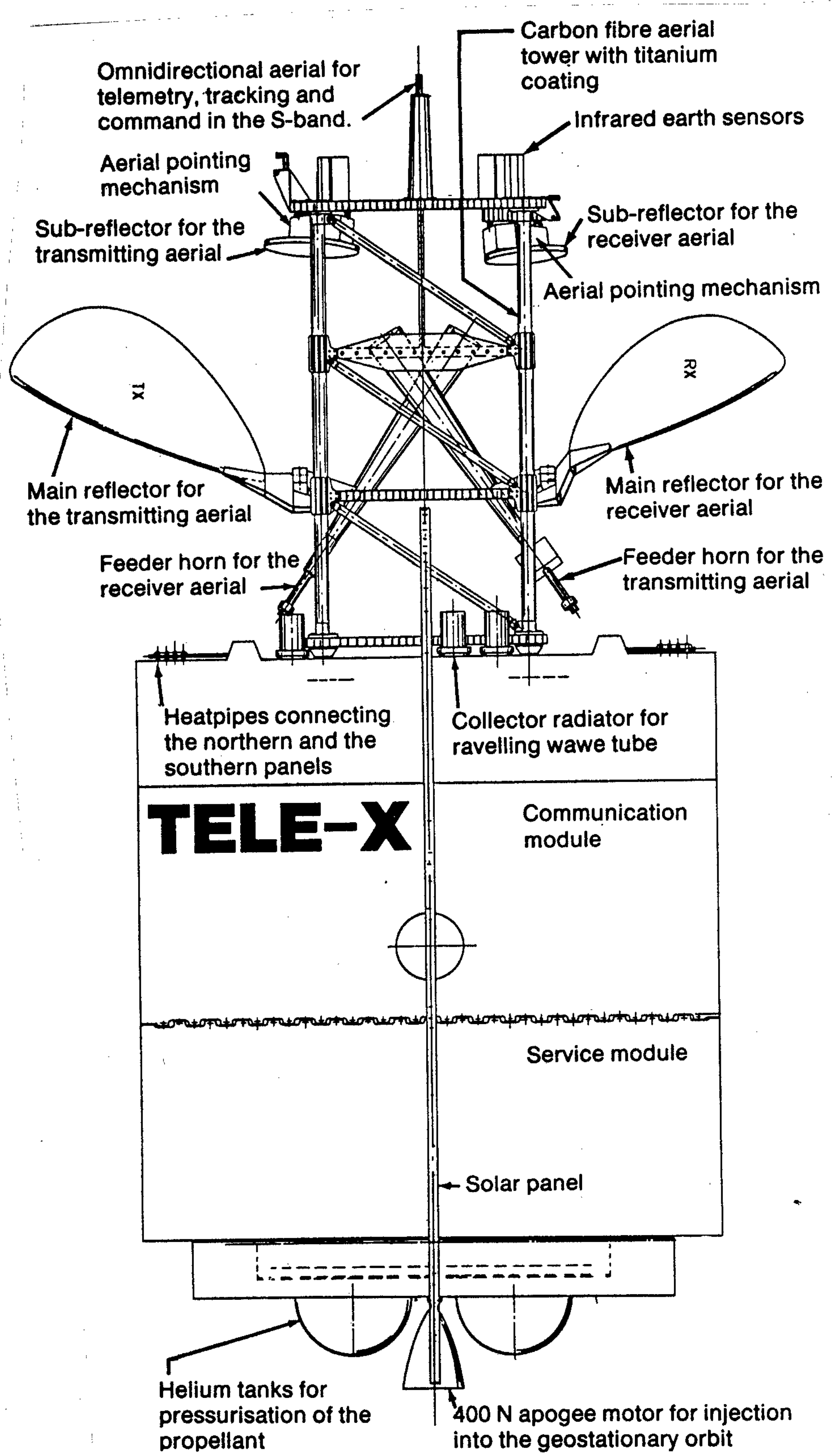


Figure 9. The satellite aerial system. Source: The Swedish Space Corporation.

company, Elektrisk Bureau. A binding tender was received for the data/video section, and this is at present (spring 1983) being assessed.

In the autumn of 1982, a letter of intent concerning the satellite was issued by the Space Corporation to Eurosatellite/Aerospatiale. Work on design, manufacture, testing and delivery (Phases C/D) has started, and it is the intention to sign a contract during the second quarter of 1983.

Finally, tenders for parts of the satellite control system have been obtained from Finnish industry and a budgetary proposal for a feeder link station from Ericsson. A request for a firm proposal for the feeder link station will be issued in the summer of 1983.

- Agreement was finally reached between the Norwegian and Swedish governments on 3 March 1983, to the effect that Norway would be responsible for 15% of the cost of the TELE-X project. This has permitted the negotiations for an agreement to establish the structure of a future permanent organisation to be concluded. Corresponding negotiations have also been started with Finland, but no final decision has yet been reached.

This work is to be followed by completion of the technical specifications for the earth segment and control system, and the signing of contracts with the suppliers. The intention is to sign these contracts in the autumn of 1983. The coordinating negotiations must also be completed and work must be started on detailed planning for the experiments. Design reviews will be conducted with the industrial contractors at intervals, until the equipment is supplied.

- It will be noted from the above description that the work so far completed has been carried out under considerable pressure, which has been necessary if the satellite was to be ready for placing in orbit during 1986 as planned. This may seem surprising, but the time between now and the beginning of 1986 is all required for design, manufacture and testing of the satellite, earth stations and control system. After the launch and the acceptance tests, the experimental phase will start and will last for about two years. If the results are successful, the system will then be taken into pre-operational use. The life of the satellite is estimated to be between five and seven years, and is determined primarily by the amount of propellant that can be carried to maintain it in the correct position and orientation.

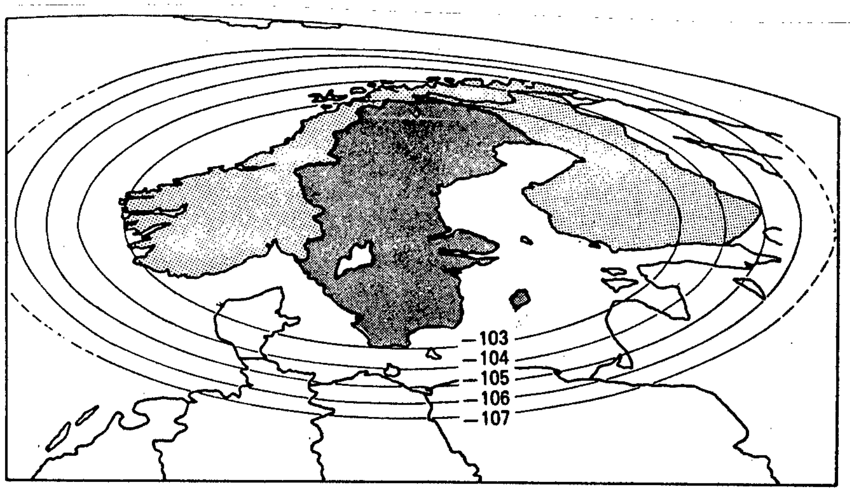


Figure 10. The coverage area for the TELE-X broadcasting experiment (dBW/m^2). $-103\ dBW/m^2$ 2 = 50 pW/m^2. Source: The Swedish Space Corporation.

Conclusion

Whether the TELE-X system will form part of a future Nordic satellite system and whether it will be followed by subsequent satellites of similar design, or whether it will not have any successors, will depend on the result of the present NORDSAT investigation, and of the decisions arising out of the investigation. However, work is proceeding on the assumption that TELE-X will constitute a stepping stone towards an operational system which might be in operation by the end of the 1980s.

The TELE-X concept capacity can be expanded with only minor modifications to include three broadcasting channels and two data/video channels for Denmark, Finland, Norway and Sweden, together with a broadcasting channel for Iceland.

If all goes according to plan, the TELE-X satellite will be put into orbit by an Ariane rocket, launched from Kourou in South America (suitably sited for equatorial launches) sometime in the autumn of 1986. This will mark an important step forward in the development of telecommunications in the Nordic countries. ■

CSO: 5500/2520

ESA SIGNS CONTRACT TO LAUNCH ECS-3 WITH ARIANESPACE

Paris AFP SCIENCES in French 6 Oct 83 p 10

[Text] Ariane has a new contract. A contract for launching the third European telecommunications satellite, the ECS-3, with the Ariane rocket, was recently signed by ESA and Arianespace, according to spokesmen for both companies.

The new contract reportedly brings Arianespace's orders to a total of 5.2 billion francs for the launching of 25 satellites.

The ECS-3 satellite is the third in a series of five European telecommunications satellites designed and built by ESA for the European industry. Its launch is slated for August 1985, with an Ariane-3 launcher. It will follow that of ECS-2, which should come in May 1984.

The ECS system offers a great many services, including forwarding of international telecommunications among the members of the European Postal and Telecommunications Conference (CEPT), broadcast of TV programming among the members of the European Radio Broadcasting Union (UER) and, beginning with ECS-2, a range of various services requiring only relatively simple ground installations.

The first ECS satellite was successfully launched by Ariane on 16 June of this year. It should be operational within a few weeks, and it will then become an integral part of the EUTELSAT system, the interim European organization for satellite communications, with headquarters in Paris.

In the area of telecommunications alone, ESA's contracts already signed for launching two MARECS maritime telecommunications satellites, three ECS satellites, and the giant OLYMPUS satellite for European telecommunications and direct broadcasting, amount to 1.6 billion francs.

6182

CSO: 5500/2511

INDIA TO RECEIVE PHOTOS FROM SPOT REMOTE SENSING SATELLITE

Paris AFP SCIENCES in French 6 Oct 83 p 15

[TEXT] New Delhi -- India will use the SPOT remote sensing system to help with its urban planning, beginning in 1985.

A budget of 150 million rupees $15 million) has been committed to set up ground installations to receive pictures from the SPOT satellite, it was announced at a press conference held by Prof DEEKSHATULU, director of the National Remote Sensing Agency (NRSA), whose headquarters are in Hyderabad, in southern India.

Sources in Paris say that India's decision is the logical outcome of talks begun in 1981, which were continued last February in the course of Franco-Indian talks on space cooperation efforts already in effect between the CNES and ISRO

The agreement on India's use of the SPOT pictures has not yet been signed, but negotiations are continuing.

There is not much expectation in French quarters that India, which has a receiving station at Hyderabad to pick up pictures from the American Landsat satellites (first-generation Landsat-1, -2, and -3) built by Ford Aerospace and ISRO engineers, will try to buy a SPOT station of its own, but the Indian experts may decide to modify and upgrade their Landsat installations by buying some French equipment.

Sources say that SPOT-IMAGES, the company set up to market SPOT satellite pictures, is currently negotiating with several countries.

SPOT-1 will be launched in late 1984 or early 1985 at the same time as the Swedish scientific satellite, Viking, aboard an Ariane-3 rocket; with SPOT-2 slated for a year later, since the life-span of these remote sensing satallites for detection of Earth resources is 2 years.

Current estimates set the cost of a SPOT photo covering a region of 60 square kilometers at $1,000, for either 20m color or 10m black-and-white resolution.

Latest CNES figures set total cost of the SPOT program at 2.5 billion francs.

6182

CSO: 5500/2511

ITALTEL R&D ON LOCAL NETWORK SYSTEM WITH DIGITAL PABX

Milan ALTA FREQUENZA in English Mar-Apr 83 pp 129-134

[Article by Marco Bozzetti, Guiseppe Marvel Padovani and Aldo Perna]

[Text]

Abstract. Italtel R & D Laboratories have undertaken research activities in order to define a telematic architecture for private environments, with particular emphasis on an integrated subscriber system for voice, text and data.

The utilisation of PABXs constitutes the basic support for a gradual services' integration in a local area. The paper focalizes the local network based on digital PABX, which represents a fundamental step through the integration in techniques and services.

INTRODUCTION: AN APPROACH TO TELEMATICS

The present impressive technological evolution, together with the systemistic and technical evolution in telecommunication and informatic fields have driven to an even more growing convergence of these two worlds, creating a new field, the *telematic*, that will open a new era, the "information era".

In the past, Italtel gained a big experience in the field of both public and private networks, with study, design and production of several systems, that utilize different techniques and technologies: among them, let us underline the time division public electronic switching system "PROTEO" [PROT 81] for the public market, and the private automatic branch exchange "ANDROMEDA" [ANDRO 80] for the private one.

For the private environment, the main aim is to gradually pursue a growing sophistication and integration of the present and future teleinformatic services, facing in a global and systemistic fashion all the aspects and the anticipated demands for joining information processing and telecommunication.

Such aim has led to undertake a research activity, whose first goal is the definition of a network architecture including different network systems. The most relevant system, for its impact on the telematic area and on the future office organization, is a "local network", integrating voice, text and data, based on a digital PABX.

The result expected from the multidisciplinar efforts undertaken is not an all-inclusive architecture to unify signalling protocols for voice, text and data, but is a frame work architecture to be referred for a systematic definition of telematics products, that will offer a set of telematics

services to the network users, with different grades of integration and performances.

The architecture design has been focalized to the interconnection of local area networks via long-haul/backbone (public and/or private) networks, providing a first level of data and voice integration in the local areas.

For the functional specifications, the basic guidelines are:

- distributed processing capability
- device independence
- system configuration flexibility
- information integrity, privacy and security
- system reliability
- international standards' compliance.

A TELEMATIC NETWORK ARCHITECTURE

A telematic network provides *services* to the users, named "end user" (EU) and is constituted by a set of *user subsystems* (US) connected via *connection tools* (CT) (see fig. 1).

The EU can be a human operator that utilizes network services and resources, or an application program running on a computer connected to the network.

The boundary between the end users and the network is the *end user interface*, constituted by terminal devices or by primitives, for instance by printers, keyboard and screen, telephone or by a set of software primitives such as "send file", "receive message", etc.

The US can vary from a host or an intelligent work station to a local network, the CT can vary from a simple line up to a backbone network.

In such a way, the network allows a *systems interconnection* where each system can be at its turn a network. The CT acts as a primary network (and may be reduced to a simple line) and the US acts as a secondary network (and may be reduced to a simple work station). Fig. 2 shows an example of the considered telematic network.

Starting from these basic and general concepts, a distinction is made between the architectural model of the network, that defines the functions and the components the network should perform, and its implementation, i.e. the actual occurrence of the architectural model (software and hardware modular components).

The model of the network architecture

The network architecture defines the *telematic services* and the *network logical units (NLU)*, the first concerning with the services, hierarchically subdivided in "connection", "communication" and "application" services layered in seven levels as defined in the OSI reference model [ISO 80], the second one concerning with the logical components of the network that provide some functions for the above services.

The implementation of one, or the implementation of a combination of more than one NLU constitutes a *network product*.

In other words, it is defined a logical network, seen as an example of teleinformatics services provided by a

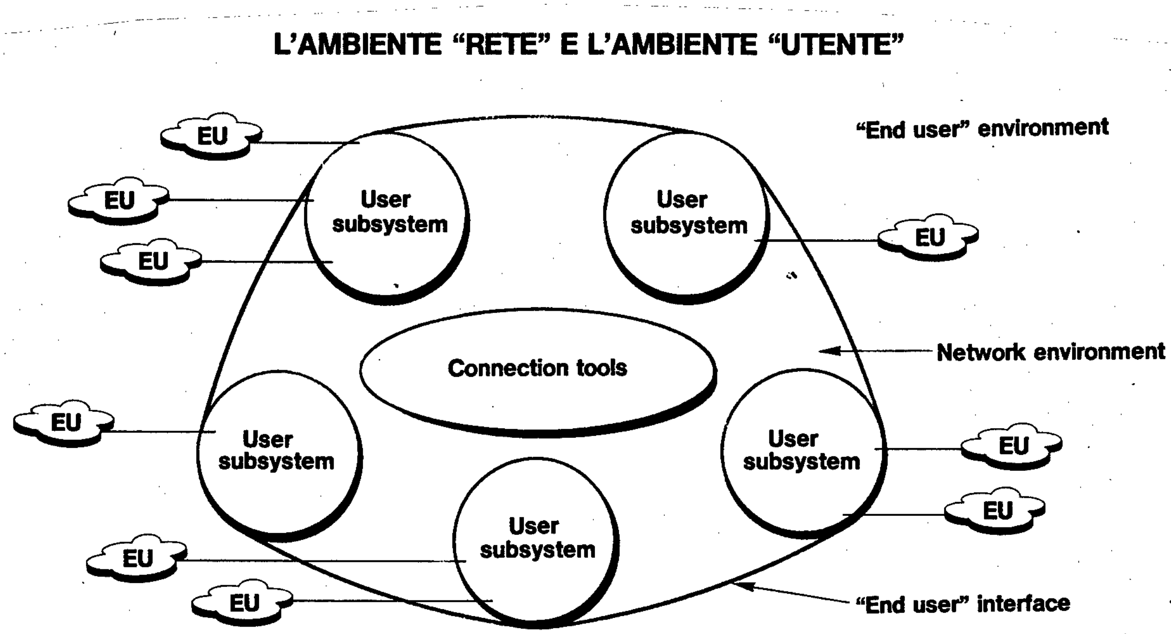
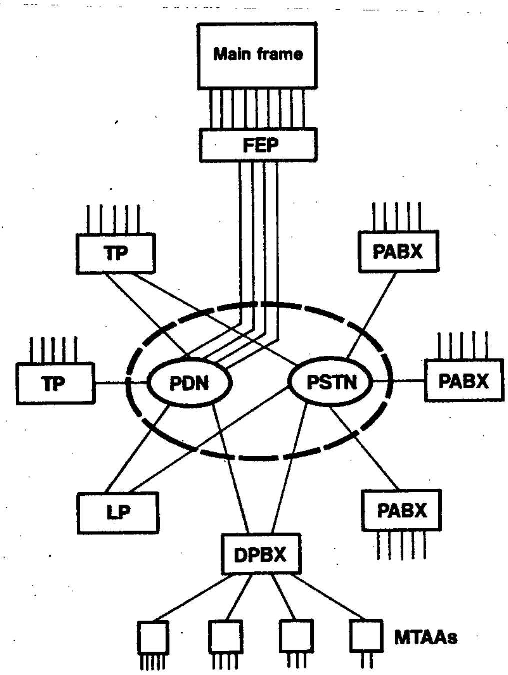


Fig. 1 - "End User" and network environments



FEP = Front End Processor
TP = Terminal Processor
LP = Local Processor
PABX = Private Automatic Branch Exchange
DPBX = Digital PABX integrated in the services
MTAA = Multiservice Terminal Access Arrangements
PDN = Public Data Network
PSTN = Public Switching Telephone Network

Fig. 2 - An example of the considered network

set of logical network units connected together via some transmission medias; such a logical network is realized phisically via some products, that are the actual occurrences of one (or more) NLU.

Fig. 3 shows these two views of the network.

One NLU can be a part of the TT or of the US: Table 1 gives the list of the NLUs till now defined, indicating if they can act as a US, as a CT or both.

Table 1: Some possible network logical units

NETWORK LOGICAL UNIT	CT	US
Packet switching node	X	
Ground station node	X	
Terminal Processor		X
Work Station		X
Local Processor		X
Front End Processor		X
Main Frame Host		X
Network Control Centre	X	X
Gateway Processor	X	X
Statistical Multiplexer	X	X
PABX		X
DPBX		X
MTAA		X

The network, strictly following the OSI reference model and its layering principles, is structured in seven layers, from the bottom the Phisical, the Link, the Network, the Transport, the Session, the Presentation, the Application, grouped in three functional services' bands, the Connection, the Communication and the Application ones (fig. 4).

The Connection band covers the first three lower layers, i.e. the phisical, the link and the network ones. They strictly depend on the transmission medias and the transmission techniques, e.g. telephone lines, satellite and radio channels, coaxial or optical fiber cables, etc. for transmission medias and packet switching, circuit switching, TDM, FDM, CD-CSMA (carrier sense multiple access with collision detection), etc. for the techniques.

The Communication band covers the transport and the session layers and is in charge to cover the functions not available by the specific connection service used, offering to the Application band a standard dialogue organization.

The Application band covers the last two layers, the Presentation and the Application, that deal with the representation, manipulation and processing of information.

At a generic "i" layer, in a NLU, there are one or more "objects", called *entities* that, using the lower level services, cooperate with the corresponding entities in other NLU and provide an "i" service.

Entities at the same layer communicate by means of *protocols*.

For the formal description of entities and protocols, the architectural model refers to the "theory of colloquy", based on the "interlocutor" concept [LEMO 80].

An EU can interwork and colloquy with other EUs of the network by means of suitable interactions named *associations*, that provide relationship between the two (or more) partners.

In order to put in association two or more EUs, the network provides an ideal pipe, called *session*, for the exchange of messages and the organization of the dialogue.

The session utilizes lower level paths, established by the lower layers. The session is the highest level connection path between two (or more) entities. The session is completely independent from the type of EU and of the side where he is. As an example, two application programs interwork via a session independently whether they are local inside the same computer, or they are in different remote computers. The session is the same standard communication path, with the same interface primitives to its "user", that in the first case will utilize the communication facilities provided by the operating system of the computer, in the second case will utilize the "Transport Path" performed by the Transport Layer.

The *Transport Path* plays a key role in the interconnection of EUs of different NLUs, because it isolates the session from the different transmission tools techniques and medias.

At its turn the Transport path utilizes the *Connection Path* provided by the connection band, which feature and performance depend on the used transmission media and technique.

Fig. 4 shows the paths used by the association between two EUs at two NLUs connected via a public packet-switching network with X.25 interface.

Services and protocols

The network uses, for each layer, the available standard protocols defined by the ISO and CCITT (refer to the documents listed in the References). For the not yet

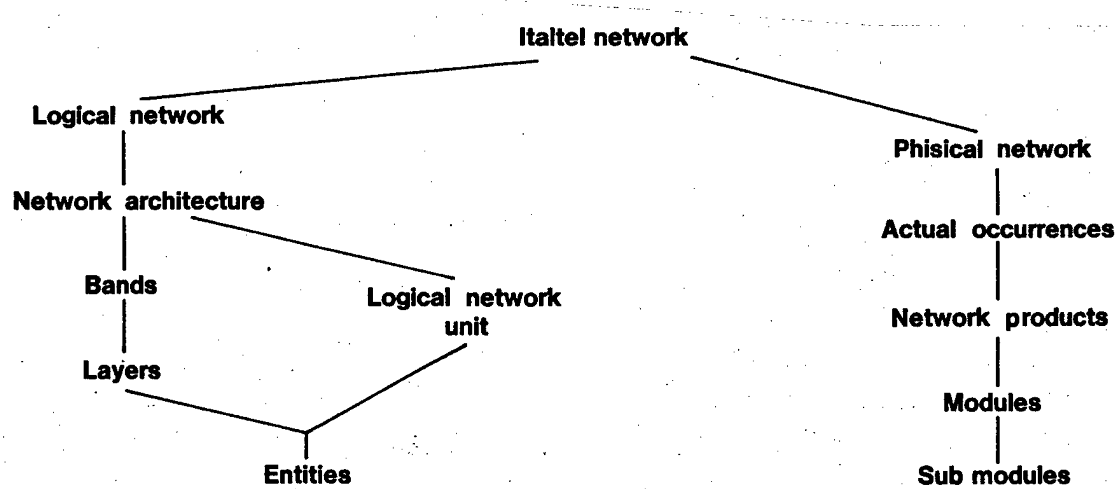


Fig. 3 - The architectural model and its actual occurrences

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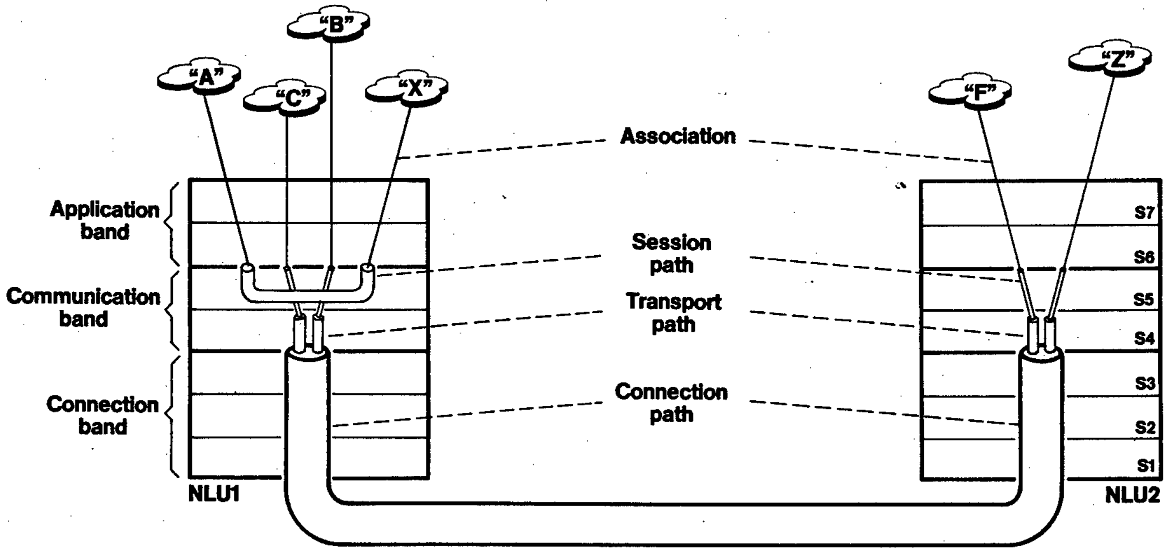


Fig. 4 - The architectural model: bands, layers, association and paths

Table 2: Some foreseen telematics services

BAND	SERVICES	PROTOCOLS
APPLICATION	electronic mail	internal standard
	file transfer	standard ECMA
	job transfer and manipulation	standard ISO
	text processing	no standard
	virtual terminal	standard ECMA
	network control and management	no standard
	automatic secretary	no standard
	teletex	standard CCITT
COMMUNICATION	session	standard ECMA
	transport	standard ISO
CONNECTION	virtual circuit	standard CCITT
	circuit switching	standard CCITT
	telephone circuit	standard CCITT
	radio channel	standard CCIR
	satellite channel	standard CCIR
	link	standard ISO & other protocols

defined protocols, it uses the "de facto" commonly agreed protocols (e.g. BSC) or those supported by National Bodies and by ECMA (e.g. File Transfer and Virtual Terminal).

Services provided by the three bands can be distinguished in traditional telephone and data services, and new teleinformatics services.

The main services of a telematic network are:

- traditional telephone services
- automatic secretary
- facsimile [FAC 80]
- text processing

- electronic mail
- file transfer [FTP 80]
- information archival and retrieval
- job transfer and manipulation [JTM 80]
- network control and management
- teletex [SCITT 80]
- videotex [VCITT 80].

Some services of the communication and connection bands are directly accessed by human operators, which directly performs, by means of their brains, eyes, ears, hands and mouths, the functions of the application band.

A typical example is the traditional telephone service: it involves only the transmission bands, that sets up the circuit between the telephone sets. It is a duty of the two EUs, the human beings, to organize their colloquy (communication band service) and to understand the meaning of the exchanged sentences (application band service).

Table 2 lists some services and the related protocols performed by the three bands.

A LOCAL NETWORK BASED ON DIGITAL PABX

In the considered architecture, one of the most important "User Subsystem" is a star local network based on a services' integrated digital PABX, hereafter named DPBX.

This US handles both voice, text and data traffics and allows the connection of not only telephone sets, which will continue to dominate the modern office scenario, but also interactive and batch data terminals and other specialised terminals like telemetry equipment, remote alarms and low scan video.

The basic NLUs of this star local network are: the *DPBX*, constituted by a digital PABX integrating data and voice switching and a Local Processor with high level processing capabilities, and a variable number of *Multiservice Terminal Access Arrangements*, supporting various devices as telephone, video terminal, printer etc. (fig. 5).

The local network structure

The local network approach adopted for the provision of integrated services is inspired by the current international standardization efforts for Integrated Services Digital Networks (ISDN) [SWDA 80], [ATT 80], [SGITT 80].

The related products witness the convergence of three traditionally separated product areas: telecommunications, digital exchanges and data processing machines.

The local network US is a part of the network and, at its turn, follows the above described layered architecture, performing the services of the connection, communication and application bands.

The connection band provides basic, large capacity (up to hundreds of trunks and thousands of access lines), circuit switching services which represent the heart of the office internal transmission system and makes use of the simple, economical telephone twisted wire pairs for user connections. The transmission bandwidth on a single con-

nection due to the use of advanced PCM transmission, switching and multiplexing techniques and to the development of low cost Terminal Access Arrangements, permits access transmission rates as high as (64 + Delta) kbit/s where Delta may be 8 or 16 kbit/s for the simultaneous, transparent handling of voice, data and text information.

The main advantage of the circuit switching technique is to keep intact the peculiar qualities of the traffic handled independently of traffic type.

The communication and application bands provide data and text processing services. Most of the services offered are modularly tailored and optionally added, and depend on the user specific requirements and on the desired network sophistication.

Higher level services include *protocols* for local and remote device intra and interworking, and *office oriented applications* such as electronic mail, electronic document filing and retrieval, and word and text processing.

The bimodal switching/processing DPBX

The system structure reflects current trends for computer controlled PCM exchanges having capabilities to handle services other than telephony and to connect mixed inputs of digital data, text, facsimile, and voice information.

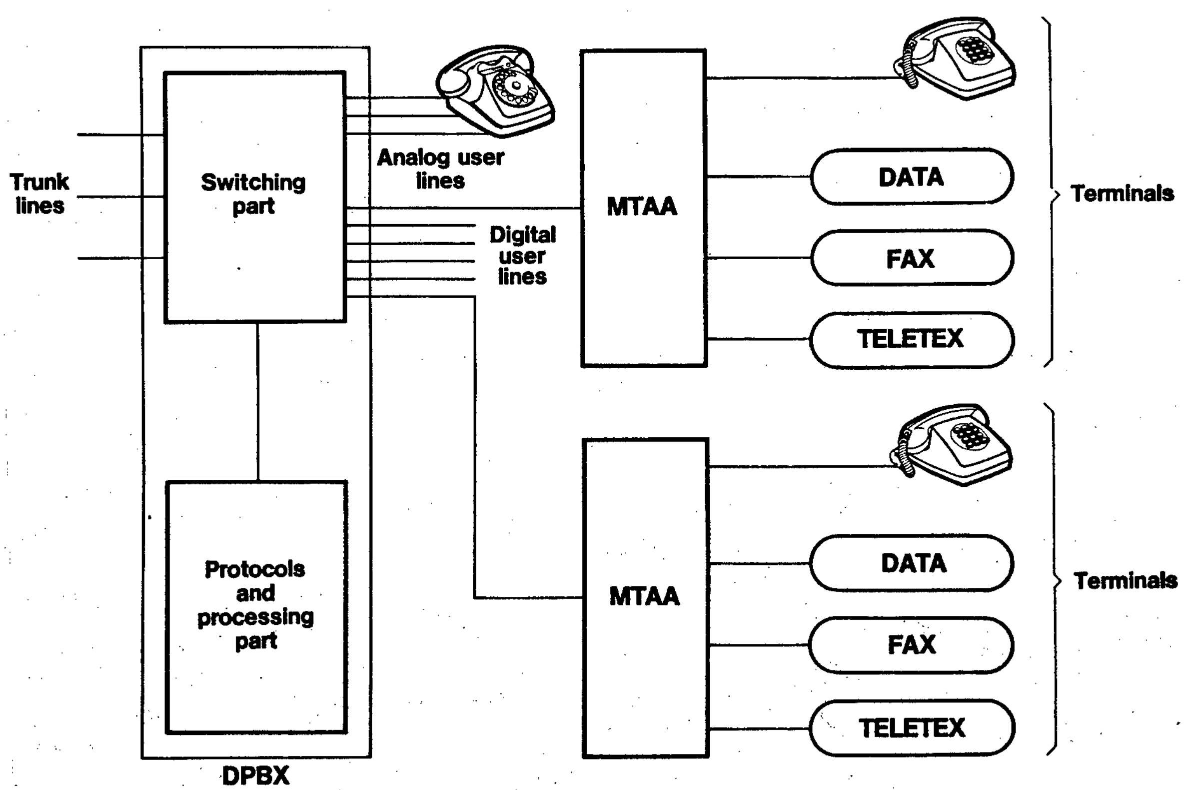


Fig. 5 - The DPBX based local network

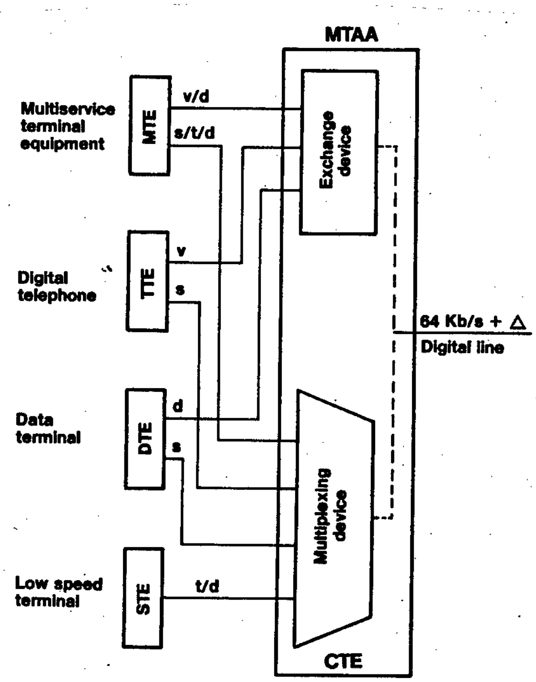
Additional entities of the Local Processor provide specific data processing capabilities.

The system is plainly modular, it is configurable in star as well as in meshed networks and handles thousands of user access lines, both analog and digital (72-80 kbps each), and hundreds of *trunks*, both analog or digital 64 kbit/s time-division channels on 2 Mbit/s PCM systems.

Modular software packages for switching, maintenance and administration form the basic software while office oriented or user specific software is optional.

Examples of office oriented optional facilities:

— Dictation document access and control
— Conference
— Mail box
— Store and forward and delayed call
— Call queueing
— Automatic secretary
— Automatic message accounting
— Electronic filing.



t = text
d = data
s = signalling
v = digitized voice

Fig. 6 - The "Multiservice Terminal Access Arrangements" structure

Multiservice Terminal Access Arrangement

Different attachment interfaces allow economic and simultaneous connection of single or multiple terminals handling different types of traffic. The access protocols permit in fact single or multiple simultaneous operation. The signalling protocols used in the circuit switching ground environment are automated and CCITT compatible for voice, data and text traffic.

A functional representation of the user access arrangement is shown in fig. 6.

Three types of access to DPBX digital local exchange are traced:

— the analog telephone line that will continue to be widely used;

— the digital line consisting of a basic full-duplex two-way simultaneous 64 kbit/s digital transmission channel designated as the *in-band channel*, and a serving signalling channel at Delta kbit/s (most likely Delta = 16 kbit/s), hereafter called *out-band* channel;

— the trunk line connecting a DPBX to the "connection tools" and/or to other NLUs of the same US.

While the in-band channel is alternately used for 64 kbit/s PCM voice generated by the digital Telephone Terminal Equipment (TTE) and for data generated by the Data Terminal Equipment (DTE) at 64 kbit/s or lower rate padded up to channel bandwidth by the Circuit Terminating Equipment (CTE), the out-band channel is used to convey signalling information and data in the case of low Speed Terminal Equipments (STE).

CONCLUSION

The concepts and ideas described in the present paper are first conclusions of a research activity in the telematic field, delineating a possible architecture, very close to the present status of the art and to the current international standard activities, and defining some network systems, as the local net based on a digital PABX.

A further step will be a clear definition of hardware and software modules to be grouped in products consistent with the above defined architecture, allowing the introduction of new telematic services for voice, text data and facsimile.

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CSO: 5500/2522

DESCRIPTION OF 9600 BPS MICROPROCESSOR MODEM PROTOTYPE

Milan ALTA FREQUENZA in English Jul-Aug 83 pp 244-255

[Article by Marco Ajmone Marsan, Guido Albertengo, Sergio Benedetto, Dante Del Corso]

[Text]

Abstract - This paper describes the implementation of an all digital 9600 bps Modem prototype. The modem experimental setup was built in order to verify several algorithms expressly developed for a completely digital modem implementation. The hardware design is based on two Signetics 8X300 microcontrollers that supervise the operations of the receiving and of the transmitting sections. Details are presented in the paper on both software and hardware modem components. Important characteristics of the modem are the direct in band generation of the line signal, the optimization of the FIR filters for signal generation in order to minimize the error probability, and a new carrier and bit synchronization procedure that only requires one sample of the received signal per each baud interval. The performance of the experimental modem prototype was measured using a laboratory channel model. Experimental results are compared with theoretical and simulation curves.

1. INTRODUCTION

In the past few years, digital signal processing techniques have gained increasing ground in data transmission applications, affecting even those subsystems that match the characteristics of the transmission media. Though the initial impulse was certainly due to the low cost, easy reproducibility and high reliability of the integrated digital circuits, the advent of fast microprocessors added flexibility to these systems, allowing designers to match the increasing user requirements. Several papers describing the microprocessor implementation of medium and high speed data modems appeared in recent publications. The hardware design was based either on special purpose LSI components /1/ , or on general purpose microprocessors /2-4/ , or on both types of components /5/.

This paper describes the design of a 9600 bit/s modem prototype and its implementation using the Signetics 8X300 microcontroller as a basic device in both transmitter and receiver sections. A fast multiplier-accumulator controlled by the 8X300 was used in the modem receiver, because of its greater complexity and computational requirements.

Some solutions concerning the structure of the receiver are borrowed from previous studies in the field (e.g. /2/). Novel contributions of this research are the design method of the FIR filters for the direct in-band signal generation and the modem synchronization algorithm allowing simultaneous timing and carrier recovery in the preamble phase /6/.

The modem was designed, simulated and built with the main objective of exploring the practical microprocessor implementation of some interesting ideas like echo modulation (using a new performance criterion) and one-sample-per-baud carrier and clock synchronization. The modem prototype was built in a University laboratory, and is not meant to be a "commercial" product. At the moment, since it lacks an adaptive equalizer, it can only work over limited distance point-to-point equalized telephone lines; FDM channels are excluded because of the possibility of a frequency offset.

The synchronization algorithm for timing and carrier recovery is particularly suited to digital circuitry and works independently of the phase offset between the transmitted and the locally generated carriers.

In section 2 the modem main design choices are described; section 3 is devoted to the transmitter implementation together with a brief description of the 8X300 microcontroller. In section 4 the design of the receiver along with its software and hardware implementation are presented. Finally, section 5 describes the measured performance curves and compares them with theoretical and simulated results.

2. MODEM DESIGN CHOICES

The modem that was designed, simulated, built and tested operates at a 9600 bps data rate. The 16 points schemes, suggested by CCITT /7/ for this application, called four by four amplitude modulation (4x4 AM), scheme 1a), and modified four-phase, four-amplitude modulation (mod 4ϕ/4 AM), scheme 1b) are shown in fig. 1. Both modulation schemes can be used by the modem, by changing the programs that supervise the behavior of transmitter and receiver. Throughout the paper, for the sake of conciseness, we shall only refer to scheme 1a). Every signal point carries 4 bits of information, and the correspondence between points and sets of 4 bits according to a Gray code is shown in fig. 2.

The signal x(t) generated in the transmitter section of the modem can be mathematically represented as:

(1) $x(t)=x_P(t)\cos\omega_o t+x_Q(t)\sin\omega_o t$

where ω_o is the carrier angular frequency and $x_P(t)$ and $x_Q(t)$ are the baseband in-phase and quadrature information-bearing signals, i.e.:

(2) $x_P(t)=\sum_k \alpha_k h_1(t-kT)$

(3) $x_Q(t)=\sum_k \beta_k h_1(t-kT)$

Where T is the waveform signalling interval, $h_1(t)$ determines the spectral shaping of the transmitted signal and α_k, β_k are the coordinates of the signal points in the signal space.

In the past few years, several attempts have been made to obtain a flexible design tool for various types of data transmitters by using digital techniques to synthesize signals like (1). In particular, a few methods can be used to directly generate signal (1) avoiding the need for the multiplication by cos $\omega_o t$ and sin $\omega_o t$ /8-11/.

The implementation complexity heavily depends on the values of the carrier frequency and signalling intervals. If the product $\omega_o T$ is a multiple of 2π, then two linear systems with

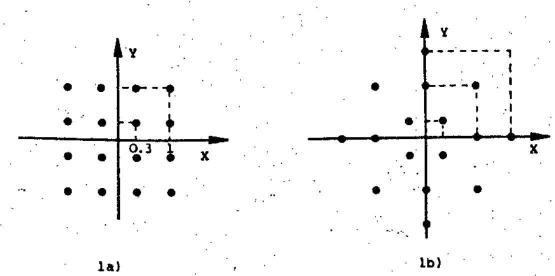

Fig. 1 - Signal spaces of the two modulation schemes used in the modem.

impulse responses $h_P(t)=h_1(t)\cdot\cos\omega_o t$ and $h_Q(t)=-h_1(t)\cdot\sin\omega_o t$ allow the direct in-band generation of the signal (1), since:

(4) $x(t)=\sum_k \alpha_k h_P(t-kT)+\sum_k \beta_k h_Q(t-kT)$

In our case, being 1/T=2400 Hz, it is impossible to choose the carrier frequency in the telephone bandwidth, 300-3400 Hz, in order to satisfy the above condition. However, we may choose ω_o so as to satisfy the less restrictive condition:

$\omega_o T=\frac{n}{m}2\pi$ n, m, relatively prime integers

with the smallest possible m. In this situation, the in-band generation of x(t) requires the synthesis of a linear system whose impulse response varies periodically with time, with period mT.

This is equivalent to using a set of m time-invariant linear systems, each one of which is chosen in the appropriate time interval. With our constraints, the simplest choice for $f_o=\omega_o/2\pi$ appeared to be f_o=1800 Hz, with n=3 and m=4.

With this choice, we must implement 4 filters for the in-phase component, with impulse responses:

$$
(5)\quad
\begin{aligned}
&h_P(t,o)=h_1(t)\cos\omega_o t && t\ \varepsilon(0,T)\\
&h_P(t,1)=h_1(t)\cos(\omega_o t+6\pi/4)=h(t)\sin\omega_o t && t\varepsilon(T,2T)\\
&h_P(t,2)=h_1(t)\cos(\omega_o t+6\pi/2)=-h_P(t,o) && t\varepsilon(2T,3T)\\
&h_P(t,3)=h_1(t)\cos(\omega_o t+9\pi/2)=-h_P(t,1) && t\varepsilon(3T,4T)
\end{aligned}
$$

and 4 for the quadrature component with impulse responses:

$$
(6)\quad
\begin{aligned}
&h_Q(t,o)=h_1(t)\sin\omega_o t=h_P(t,1)\\
&h_Q(t,1)=-h_P(t,o)\\
&h_Q(t,2)=-h_P(t,1)\\
&h_Q(t,3)=h_P(t,o)
\end{aligned}
$$

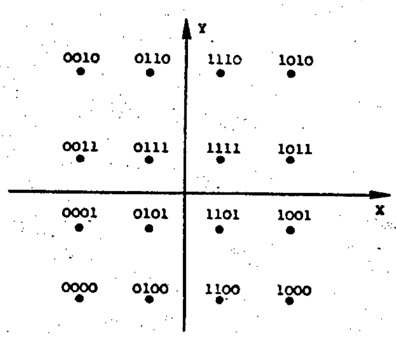

Fig. 2 - Gray code used in the prototype.

The periodic sequence of the 4 pairs of filters with impulse responses given in (5) and (6), requires that a fixed point in the signal space be represented in four subsequent intervals using different rotated axes, as shown in fig. 3. This is exactly the same as using fixed axes and rotating the signal points, like in fig. 4. The latter operation can be very simply done by the microprocessor through a pre-encoding of the four bits corresponding to each signal point, thus reducing the number of filters from eight to two.

The same technique can be applied to different choices of the carrier frequency f_o. For example, using f_o = 1700 Hz, as suggested by CCITT recommendation V 29, we have n = 17 and m = 24. Twentyfour filters are thus needed for the in-phase component, with impulse responses:

$$h_P(t,k)=h_1(t)\cos(\omega_o t+17k\pi/12)\ ,\ k=o,1,2,\dots,23$$

and twentyfour more are necessary for the quadrature component.

The same technique that allows the reduction of the number of filters with f_o = 1800 Hz can still be used, so that the total number of filters that must be implemented in the case of f_o = 1700 Hz is 12. Note that the higher number of filters does not increase the program execution time, since only one filter for each component is used in every baud period. A larger size ROM is, however, necessary in the modem transmitter to store the coefficients of the larger number of filters (the data memory shown in fig. 10).

The shaping function $h_1(t)$ in (2) and (3) corresponds to a transfer function $H_1(\omega)$ which is the square root of a raised cosine filter, with roll-off 0.3. Since an equal filter $H_2(\omega)$ is placed at the input of the receiver, the overall transfer function is of raised cosine type. This guarantees an optimum splitting of the transfer function between transmitter and receiver from the additive noise point of view /12, ch. 5/.

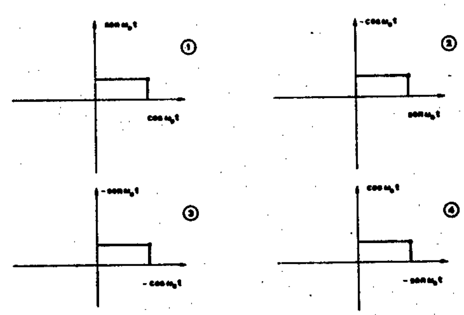

Fig. 3 - Rotation of axes.

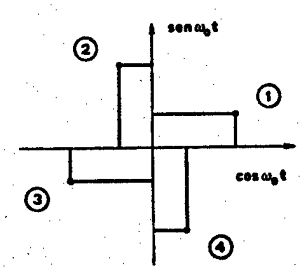

Fig. 4 - Rotation of a signal

3. THE MODEM TRANSMITTER

A functional block diagram of the modem transmitter is shown in fig. 5. The stream of binary symbols, at a speed of 9600 bps, enters the serial-to-parallel converter which groups the bits four by four. Then the four bits are pre-encoded to take into account the axes rotation as explained before, and finally the bits are encoded according to the Gray code of fig. 2, that associates to each group of four bits a point in the signal space. The in-phase and quadrature coordinates thus obtained multiply the coefficients of the impulse responses of the two filters that allow the direct-in-band generation of the line signal x(t).

The linear systems with impulse responses $h_1 \cos\omega_o t$ and $h_1 \sin\omega_o t$ are obtained through a software subroutine that implements the structure of the two FIR filters shown in fig. 6. The design of the FIR filters requires the choice of:

- the number N of coefficients;
- the delay τ (a submultiple of T);
- the set of coefficients $\{\lambda\}_{i=1}^{N}$;
- the number of bits for the representation of each coefficient λ_i.

Among the various possibilities investigated in the literature /11/ for the choice of λ_i's, we have selected the frequency sampling applied to the impulse response to be synthesized. The choice of N and τ, or, equivalently, of N and $M=T/\tau$, was based on the minimization of the error probability P(e) of the system. Curves showing the behavior of P(e) as a function of the ratio N/M (the memory span of the filter relative to the baud rate) with M as a parameter are shown in fig. 7, for two values of the signal-to-noise ratio. Those results take into account the intersymbol interference due to the approximated raised cosine characteristic of the transmitting and receiving filters, with the assumption that the channel is an ideal band-pass filter.

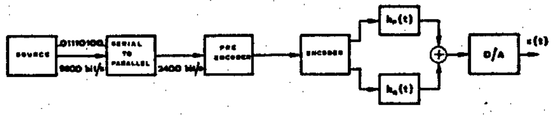

Fig. 5 - Block diagram of the modem transmitter.

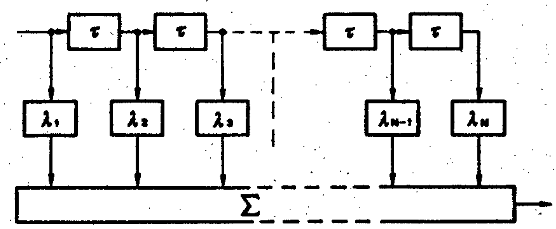

Fig. 6 - Structure of the FIR filters.

The exact error probability when intersymbol interference and additive Gaussian noise are present, was computed using the Gauss Quadrature Rule method described in /13/.

From the curves of fig. 7, it appears that a choice of the ratio N/M=6 is already a good compromise between performance and filter "length", for each value of M. We have chosen M=8, since this allows us to achieve performance quite close to the asymptotic behavior ($M=N=\infty$) with a moderate complexity of the filters, as can be seen from fig. 8.

The last parameter, i.e. the number n of bits used to represent the λ_i, was chosen according to the curves of fig. 9, in which the behavior of the error probability is shown as a

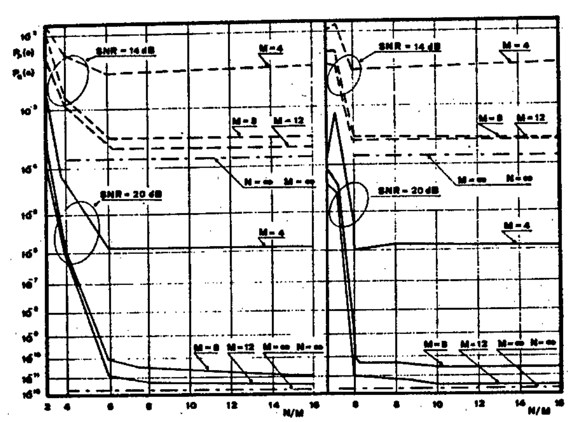

Fig. 7 - Error probability curves for the in-phase and quadrature components versus the ratio N/M, for different values of M, and for two values of SNR.

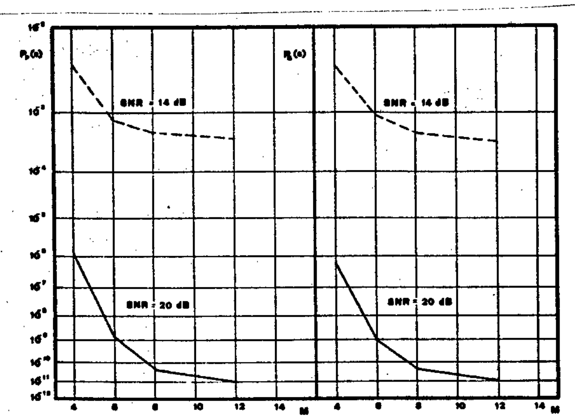

Fig. 8 - Same as Fig. 7, versus M, for N/M = 6.

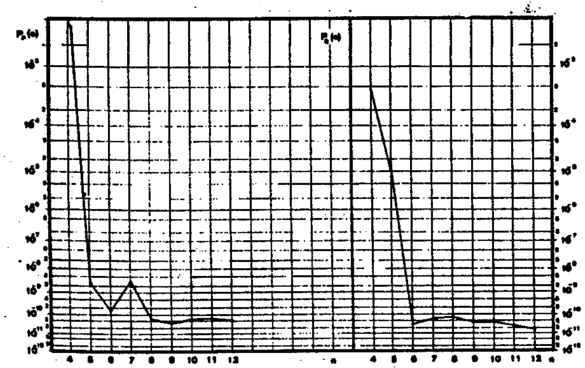

Fig. 9 - Same as Fig. 7, versus n, the number of bits used to represent the filter coefficients, for N/M = 6, and M = 8.

function of n, for the chosen values of N and M. The value n=8 was used since it is large enough to approach the asymptotic performance and since it is the word length of the selected microprocessor.

3.1 The choice of the microprocessor

The modem transmitter was the first component to be designed and built. This, together with the choice of using a fast multiplier-accumulator in the receiver, whose timing constraints are thus relaxed, has led to a microprocessor choice based on the modem transmitter. The choice of the parameters f_o and M leads to a sampling frequency $f_s = 1/\tau = M/T = 8\cdot 2400 = 19200$ samples/s. The evaluation of each output sample requires one execution of the filtering algorithm of the two FIR filters that have a time span of 6T, being N/M=6. Thus, each sample requires the sum of 12 products between the filter coefficients and the coordinates α_k, β_k corresponding to the four bits to be transmitted.

A rough estimate leads to a value of about 90 instructions to compute each sample, thus an upper bound on the microprocessor cycle time T_c can be set:

$$T_C \; \frac{1}{19200\cdot 90} = 580 \text{ ns}$$

This cycle time does not allow the use of MOS-type microprocessors, so that the design must be based on the bipolar technology. The most flexible choice would have been the use of microprogrammed bit-slice machines (such as AMD 2900 or Intel 3000 series). However, the implementation of the modem algorithms requires mainly MOVE, MASK, and SHIFT operations, so that the processor instruction set can be very simple.

Starting from this fact and considering the overall system cost (this parameter becomes remarkable if a good programming environment is desired), we moved towards fast but simple devices. A good compromise is achieved using the Signetics 8X300 "microcontroller": a high speed 8-bit bipolar processor, with an instruction set oriented towards data manipulation. A single 8X300 instruction allows multiple operations (such as MOVE, SHIFT, MASK, MERGE) to be performed on the same data.

A detailed description of the 8X300 processor can be found in /14/. The basic organization of the 8X300 machine is shown in fig 10. It follows the

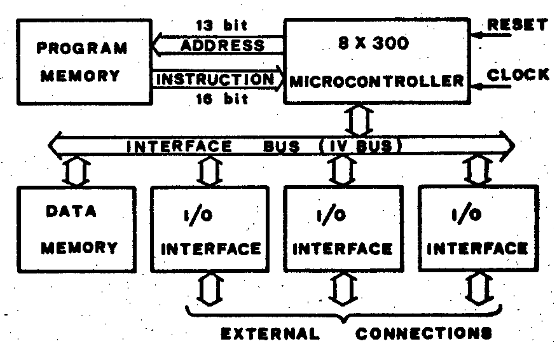

Fig. 10 - Architecture of a 8X300 based system.

Harvard architecture with separate instruction and data buses. Peripherals and data memories are tied to an Interface Vector (IV) bus, that carries multiplexed addresses and data of I/O ports.

Two address fields are defined on the bus: left bank and right bank, with separate strobes. This approach allows direct data transfer between I/O registers belonging to different banks.

The 16-bit wide operation codes follow the format shown in fig. 11. A single instruction can activate multiple operations; for instance the code:

000 10010 010 11100

means:

1) read selected left bank input register into CPU temporary register;
2) shift this data 5 bits right;
3) mask all but the 2 least significant bits;
4) shift 3 bits left;
5) merge with previous temporary register content;
6) write data to selected right bank I/O port.

0 – 2	3 – 7	8 – 10	11 – 15
OP CODE	SOURCE	ROT/MERGE	DESTINATION

Fig. 11 - Instruction format.

The developement support for the 8X300 machine was organized around existing laboratory resources: a PDP 11 minicomputer and some general purpose microprocessor developement systems. A cross-assembler was developed on the PDP 11. All the facilities of the mini, such as mass memory and peripherals are thus available to the software development process.

The 8X300 prototype hardware was organized as shown in fig. 12. The program memory consists of a dual port RAM, loaded from a Z80-based developement system. In addition some very simple hardware tools are directly tied to the 8X300 prototype to allow single step execution, bus monitoring, and direct operator I/O for basic debugging operations.

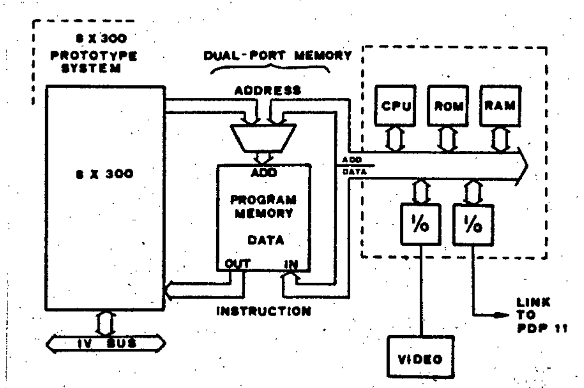

Fig. 12 - Block diagram of the 8X300 development system.

3.2 Hardware implementation of the transmitter

After the testing and debugging phases, the processor section of the prototype system, was rebuilt in the final version, with the 8X300 program stored in fusible-link PROMs. This program implements the pre-encoding and the filtering algorithms described in section 3.
In our case, since the filter input samples can have only four values that are constant over the signalling period, it is possible to simplify the filtering algorithm implementation. The coefficients which correspond to samples of the same value are accumulated in four separate registers. The intermediate results are then multiplied by the proper sample values, thus heavily reducing the number of products.

A block diagram of the complete modem transmitter is shown in fig. 13.

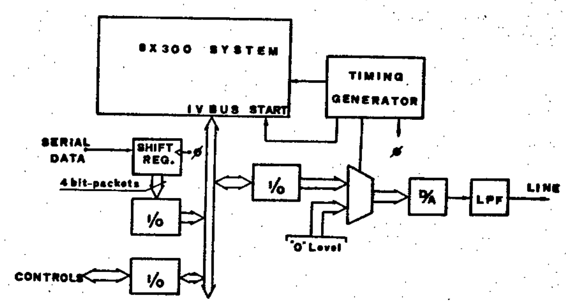

Fig. 13 - Block diagram of the modem transmitter.

4. THE MODEM RECEIVER

The receiver section of the modem can be functionally represented by the block diagram of fig. 14. The A/D input converter was omitted in order to simplify the notation, but obviously all the operations described in the following paragraphs must be thought of as operations on sampled signals, since the receiver, like the transmitter, is completely digital.

The impulse responses of the two filters shown in fig. 14 can be written as:

(7) $h_{2P}(t)=2h_2(t)\cos\omega_o t$

(8) $h_{2Q}(t)=2h_2(t)\sin\omega_o t$

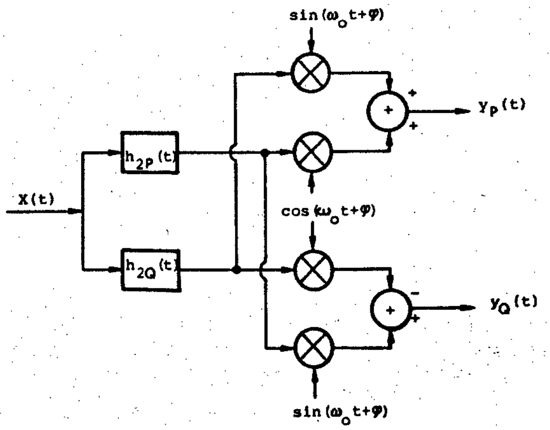

Fig. 14 - Functional block diagram of the modem receiver.

where $h_2(t)$ is the impulse response of a baseband filter whose transfer function $H_2(\omega)$ is the square root of a raised cosine filter as explained in section 2.

The structure of the receiver allows the elimination of double frequency terms generated by multiplications /2/; thus, no low-pass filtering after demodulation is needed to recover the two in-phase and quadrature baseband signals y_P and y_Q.

The absence of memory devices after the multiplications allows the digital multiplier to operate at the same sampling frequency f_s which is sufficient to represent the output quadrature signals, i.e. f_s=2400 Hz.

When the reference carrier used for demodulation is affected by a phase error ϕ and if the noise is not considered, the output signals $y_P(t)$ and $y_Q(t)$, (fig. 14) can be written as:

(9) $y_P(t)=x_{2P}(t)\cos\phi - x_{2Q}(t)\sin\phi$

(10) $y_Q(t)=x_{2P}(t)\sin\phi + x_{2Q}(t)\cos\phi$

where:

(11) $x_{\substack{2P\\2Q}}(t)=x_{\substack{P\\Q}}(t)*h_2(t)$

In order to properly demodulate and decode the received signal to obtain an estimate of the transmitted data sequence, the receiver must be able to recover a carrier at frequency f_o, coherent with the one used by the transmitter and to generate a clock signal that gives the "optimum" (in a certain sense) sampling instant.

In the following subsection we shall present an algorithm that was developed to perform those synchronization operations, and their implementation in the modem receiver.

4.1 Receiver synchronization

The algorithms for carrier and clock synchronization were tailored to the all digital modem implementation: since the modem is controlled by software, the synchronization algorithms must be executed by a microprocessor. Moreover, only one sample per baud period is available after demodulation.

The direct in-band generation of the transmitted signal gives a known constant ratio between the carrier frequency and the baud rate (provided that the signal is not frequency multiplexed or frequency converted, in which case some additions to the algorithm discussed below are necessary). It is thus possible to simultaneously adjust the sampling instant and the carrier phase.

The synchronization algorithm is made of two successive steps:

1) A training or preamble period in which a known periodic sequence is transmitted. In this period the optimum sampling instant is approached and the carrier phase is consequently adjusted.
2) A tracking period in which, during data transmission, the sampling instant is adjusted, to compensate for the relative instability of the transmitter and receiver clocks.

4.1.1 The preamble period

During the preamble period a known periodic sequence is transmitted. It is used by the receiver to estimate the optimum sampling instant and consequently adjust the carrier phase.

In order to remove the phase uncertainty, the periodic sequence must be such that any rotation of multiples of $\pi/2$ of the signal space axes cannot produce the same sequence, however shifted. The chosen periodic sequence has a period 4T, and with the notation of fig. 2 it can be written as:

..., 0010, 1010, 1000, 1010,...

Note that any shift of multiples of $\pi/2$ generates the signal 0000 that does not belong to the sequence.

If we call τ_k the sampling instant at the k-th step, and $F(\tau_k)$ a suitable timing error indicator, we can adjust the sampling instant recursively:

(12) $\tau_{k+1}=\tau_k+\gamma F(\tau_k)$

where γ is the gain of the algorithm.

The choice of the error indicator function is critical to the acquisition performance. The key requirement is that the error indicator must be zero for zero error, and must have positive derivative in the proximity of it, so as to provide a stable equilibrium condition.

The error indicator used in the modem, assuming an overall raised cosine impulse response of the channel, is:

$$(13) \quad F(\tau)=\sum_k h(\tau+T+4kT)-\sum_k h(\tau-T+4kT)$$

where h(t) is the overall impulse response of the baseband system.

Due to the periodicity of the transmitted sequence, this error indicator is periodic with period 4T. We can also write $F(\tau)$ as:

$$(14) \quad F(\tau)=\frac{1}{T}\left[H(3\pi/2T)\sin(3\pi\tau/2T)-H(\pi/2T)\sin(\pi\tau/2T)\right]$$

where $H(\omega)$ is the Fourier transform of h(t).

In our case, since $H(\omega)$ is a baseband raised cosine characteristic with rolloff 0.3, we get:

$$(15) \quad F(\tau)=-\sin\pi\tau/2T$$

which is plotted in fig. 15 (dotted curve).

Note that there are two unstable zero points for $\tau=\pm 2T$; the synchronization algorithm must take care of this situation.

If the relation between carrier phase and preamble sequence in the transmitter is known (this is the case when no frequency conversion takes place), then the adjustment of the sampling instant automatically corrects the carrier phase error, provided that the same relation is kept in the receiver.

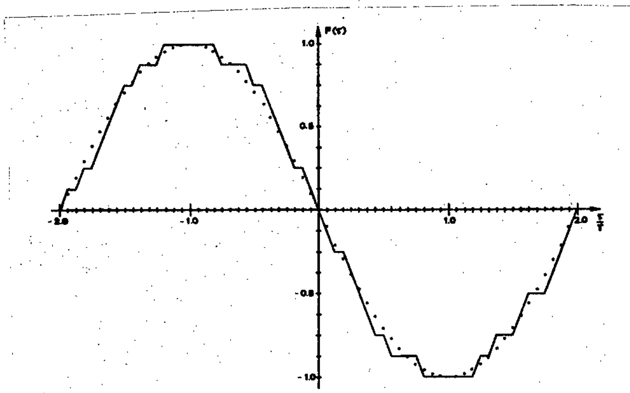

Fig. 15 - Error indicator function versus the normalized timing error. Theory (dotted line), and measurement (solid line).

The evaluation of the error indicator is discussed in detail in Appendix 1. The calculation requires several quantities in four successive baud periods to be compared; since $F(\tau)$ must be evaluated in the steady state, the sampling instant cannot be updated every baud period. The modem, in the present version, requires 6 baud periods for the evaluation of $F(\tau)$ and the correction of the timing instant.

4.1.2 The tracking period

At the end of the preamble period the transmitter begins to transmit data. The tracking of the optimum sampling instant is made using as error indicator the quantity:

$$(16) \quad F_D(\tau)=\frac{1}{2}\left[Y_{Pn}\hat{\alpha}_{n-1}+Y_{Qn}\hat{\beta}_{n-1}-Y_{Pn-1}\hat{\alpha}_n-Y_{Qn-1}\hat{\beta}_n\right]$$

where Y_{Pn} and Y_{Qn} are the in-phase and quadrature sampled outputs of the receiver; α_n and β_n are the coordinates of the transmitted point in the signal space; and $\hat{\alpha}_n$, $\hat{\beta}_n$ are their estimates, as obtained in the modem receiver.

This error indicator is an extension of the one proposed in /15/ to the two dimensional signal space. The ensemble average of $F_D(\tau)$ gives:

$$(17) \quad E\left[F_D(\tau)\right]=h(\tau+T)-h(\tau-T)$$

which has the properties required of an error indicator function.

The variance of the error indicator is easily obtained:

$$(18) \quad {}_{F_D}=2\sum_k{}' h^2(\tau+kT)-\left[2-\frac{E\left[\alpha_k^4\right]}{E^2|\alpha_k^2|}\right]\cdot\left[h^2(\tau+T)+h^2(\tau-T)\right]+\frac{2\sigma_n^2}{E\left[\alpha_k^2\right]}$$

In the tracking period the adjustment of the sampling instant is performed every several baud periods, in order to average the results obtained at each step and thus reduce the influence of errors due to thermal noise.

4.2 Design of the modem receiver

The main functions implemented in the modem receiver are: digital filtering of both in-phase and quadrature components of the line signal, demodulation, and estimation of the timing error indicator $F(\tau)$.

Only the last function is not common to the preamble and the tracking periods, as can be seen in fig. 16, where a flow-chart of the receiver program is shown.

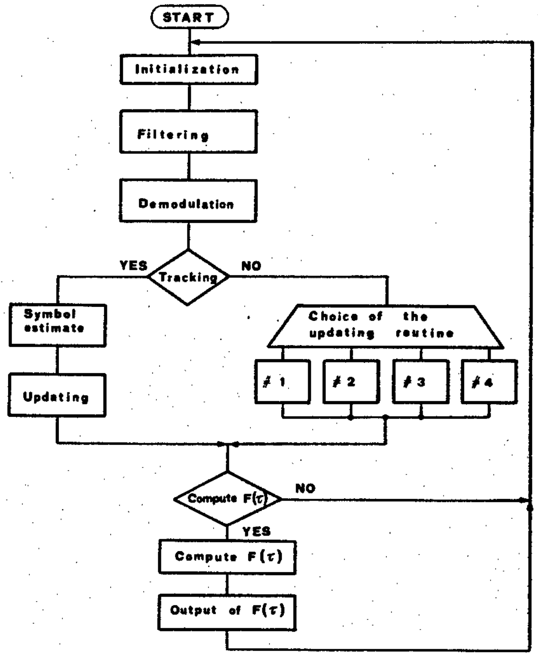

Fig. 16 – Flow chart of the receiver program.

The digital filtering is performed by two 48-tap transversal filters; therefore approximately 100 multiplications are needed in each baud period for the estimation of the transmitted bits. Other operations must also be executed in the 416 μs baud interval. Assuming that 100 μs are sufficient for all operations except the multiplications, we are left with 316 μs, so that a product should be computed in approximately 3 μs. These requirements are too tight for a software multiplication; a hardware multiplier-accumulator is necessary. The present modem implementation uses a MMI 67558 8x8 bit integrated multiplier that gives the result as a 16 bit number. Random logic is then used to accumulate results using 20 bit numbers. The final result is represented by a 16 bit word.

The availability of a fast hardware multiplier accumulator relaxes the speed constraints of the microprocessor controlling the modem receiver. The ability to control external circuitry and to perform data manipulations is a very important characteristic required of the controller. The Signetics 8X300 meets these requirements and provides enough speed to perform all operations in the baud period. Moreover, the choice of the 8X300 in our case allowed us to use all the facilities of the development system already available for the transmitter in the receiver implementation.

Using an 8 MHz clock the filtering phase requires 170 μs (680 instructions).

The demodulation of the filtered signal requires only sign changes and/or exchanges of the in-phase and quadrature components. These operations are performed in at least 15 instructions (3,75 μs).

The estimation of the error indicator (different in the preamble and in the tracking phases) is implemented with 16 bit operations in order to avoid overflow errors and thus improve the computational accuracy. The multiplier-accumulator is used for 16 bit arithmetic operations. In the preamble phase the properties of the transmitted sequence were exploited in order to save computing time. In fact, as shown in fig. 16, four different routines are used for the estimation of the timing error τ in four successive baud periods. Each routine requires approximately 310 instructions (77.5 μs). During the tracking phase the updating routine is simpler and only requires 110 instructions (27.5 μs).

The timing error estimation in the preamble phase requires one division (see appendix), whereas in the tracking phase the result of the updating algorithm already provides the timing error estimator. In the first case the division routine requires about 150 instructions (37.5 μs).In both cases the output of the timing error estimator for the correction of the sampling instant is done with 20 instructions (5 μs).

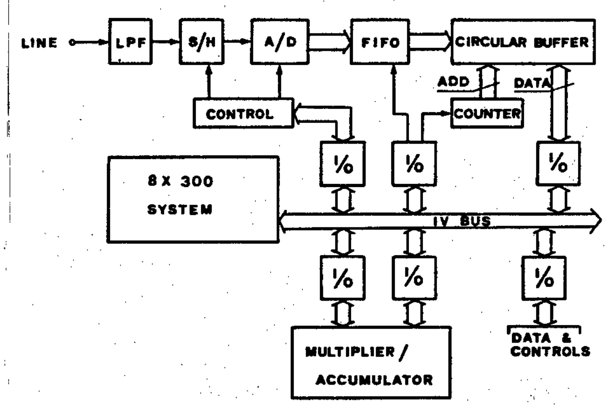

Fig. 17 – Block diagram of the modem receiver.

In the tracking phase the decision of the transmitted symbol is performed in 25 instructions (6.25 μs).

In the worst case the whole program is executed in about 320 μs, which leaves an ample time margin, given the baud period of 416μs.

4.2.1 Hardware

The choice of the 8X300 for the receiver control allows us to exploit the same development

aids already set up for the transmitter, but raises new problems. The 8X300 has no true RAM memory but only interfaces tied to the IV bus that can be used as single 8-bit read/write registers. In our case, due to the amount of intermediate results to be saved and reused, the realization of a "RAM peripheral" becomes mandatory. Moreover, since the 8X300 cannot operate on an interrupt basis, an external FIFO buffer must be used to synchronize data coming from the A/D converter (at a fixed rate) with the processor I/O operations. These two functions are implemented by an external unit composed of a FIFO buffer, a RAM memory and control circuitry.

Now it is possible to define the overall block diagram of the receiver section shown in fig. 17. The external hardware units used to assist the 8X300 in the computation are the multiplier accumulator, the external RAM memory, and the FIFO buffer. The incoming signal, after filtering, is sampled and converted to 8-bit words; samples are stored in the data RAM through the FIFO buffer. This process is organized in frames corresponding to the signalling period. The timing relationship between the input signal and the sampling frame (set of eight consecutive sampling instants pertaining to one baud period) must be varied according to F(τ) in order to synchronize the receiver in the preamble phase, and to keep the bit synchronization in the tracking phase. At the steady state, each frame contains 8 samples, whereas during the transients, the number of samples can vary between 4 and 12.

The value of F(τ) is computed as a 4-bit number, of which the three most significant bits define the number of samples in the current frame. The least significant bit shifts the sampling instant of T/16 for a finer adjustment, by inverting the polarity of the square wave that synchronizes the A/D converter.

The auxiliary RAM is divided in two banks. The first one is a circular buffer addressed by a modulo-48 counter, incremented by the acquisition logic during the data transfer from the FIFO to the RAM, and incremented by the CPU during the filtering operations. The second bank is randomly addressed through the I/O ports of the processor and is used to store intermediate results.

The multiplier-accumulator evaluates intermediate results for the filtering algorithm by computing the function:

$$F = a_1 x_1 + a_2 x_2 + a_3 x_3 + \dots + a_n x_n$$

where the a_i's are the tap weights and the x_i's are the signal samples. The block diagram of this circuit is shown in fig. 18. Since the number of I/O ports connected to the IV bus is limited by the driving power, the design minimizes these interfaces at the expense of some logic.

The multiplier-accumulator operates on 8-bit numbers. It uses an integrated 8x8 multiplier and random logic for the accumulator (fully integrated devices were not yet available).
The 16-bit products are accumulated in a 20-bit register. The 16 most significant bits of the result are read by the processor as two bytes. The complete product and sum operation is completed in less than 200 nsec; this time is shorter than the minimum interval allowed between two data transfers on the IV bus, therefore no synchronization logic towards the processor is required, and the 8X300 can send data and read results as consecutive operations.

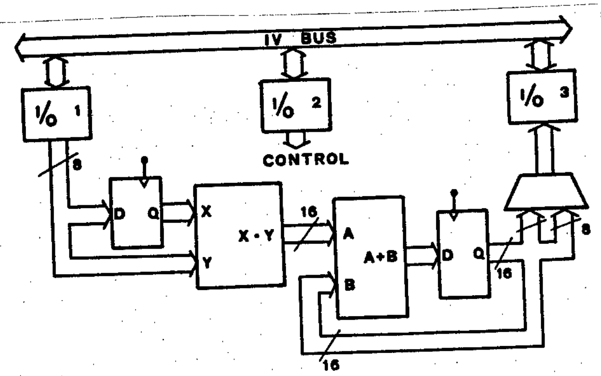

Fig. 18 - Block diagram of the multiplier-accumulator.

5. EXPERIMENTAL RESULTS

The previously described experimental modem prototype was submitted to a series of laboratory tests, whose results are presented in this section.

First of all, the line waveform generated by the transmitter during the preamble phase was compared to the one obtained by computer simulation. The channel was simulated using a band-pass 8-pole Butterworth filter with 2012 Hz central frequency, and 3975 Hz 3 dB bandwidth. All laboratory tests were performed using this filter as a channel model. The eye diagrams relative to the experimental and simulation tests are presented in fig. 19 and 20 where the two results agree very well. The second series of tests concerned the transient behavior of the synchronization algorithm. Measurement results were obtained using two different settings:

1) transmitter and receiver were frequency synchronized in order to observe the behavior of the algorithm during the acquisition of the optimum sampling instant, before the correction of the phase error.

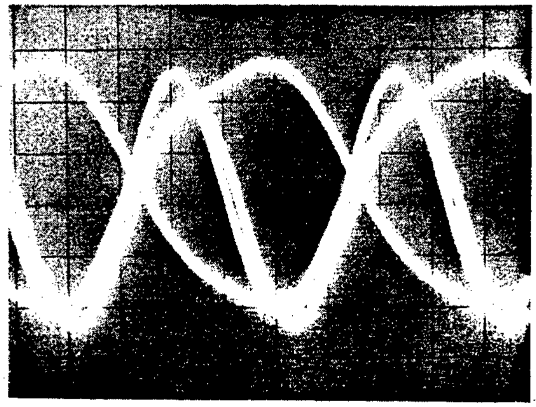

Fig. 19 – Experimental eye pattern.

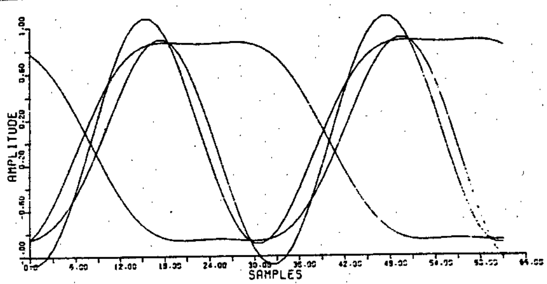

Fig. 20 – Simulated eye pattern.

2) two separate clocks were used in the modem transmitter and receiver to test the behavior of the algorithm when a small frequency offset is introduced.

In the first case, the transient behavior of the sampling instant was observed during the preamble phase. Results were obtained using a testing routine that moves the sampling instant away from the "optimum" to any desired position in the range (-2T, 2T), and records the transient values of F(τ). In fig. 21 a curve showing one particular transient is presented. It refers to the worst situation, since the initial error is equal to 31T/16. The dashed curve refers to the measured results, whereas the continuous curve refers to simulation. Both were obtained with a signal-to-noise ratio equal to 50 dB. Using the same method we measured the discrete shape of the function F(τ), which is shown in fig. 15 (solid line), together with the analytic expression (dotted line). The steeper slope of the actual F(τ) allows the receiver to reach the optimum sampling instant in a shorter time. This explains the difference between the two transients in fig. 21.

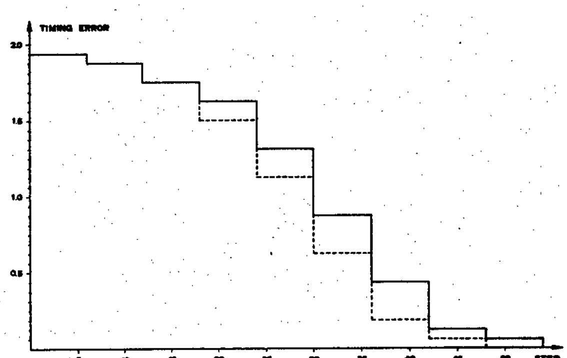

Fig. 21 – Example of timing acquisition transient in the preamble phase.

Using the second experimental set-up, we observed the value of the timing jitter with respect to the baud and sampling periods. In fig. 22 a drawn version of a photograph is presented for the sake of clarity. The upper trace represents the 19,200 Hz waveform whose rising (or falling) edges are used to obtain the sampling instants. The lower trace represents the clock pulse at the baud rate in the receiver; this pulse is 17 µs wide (continuous line). Due to the frequency offset between the transmitter and receiver clocks, this pulse moves around the optimum position, to which it is forced to go back by the algorithm. The measured range of pulse positions is shown in the figure by the dashed line. The maximum distance from the optimum sampling instant is about 20 µs, or, in baud period units, less than T/16.

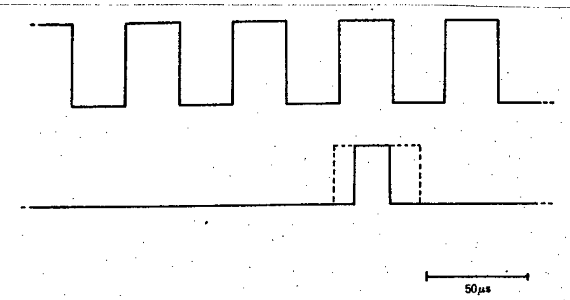

Fig. 22 – Observed timing jitter (drawn from a photograph).

Finally, the modem was tested while transmitting data. The modem performance was evaluated by measuring the error probability, with the experimental set-up shown in fig. 23. The error probability as a function of the signal-to-noise ratio is shown in fig. 24. The continuous line represents the theoretical error probability with no intersymbol interference, for the binary sequence used in the measurements. The dashed curve refers to the measured performance with the optimum sampling instant. Approximately 0.5 dB are lost with respect to the ideal case. The third curve (dotted line), gives the measured error probability with a sampling error equal to T/32, and shows the error probability sensitivity to the timing jitter. The different slope of the last curve was analitically verified, and it is due to intersymbol and cochannel interference.

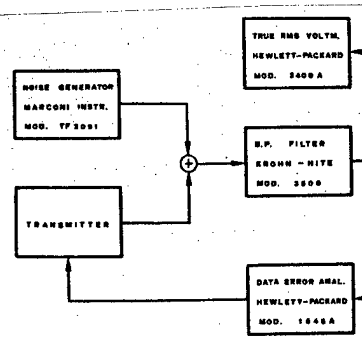

Fig. 23 - Experimental set-up for error probability measurements.

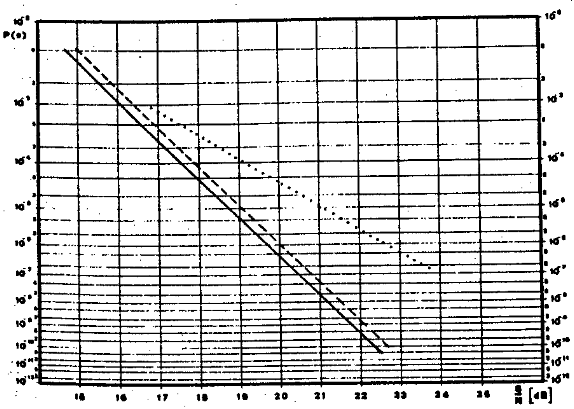

Fig. 24 - Measured error probability with the optimum sampling instant (dashed line), and with a timing error equal to T/32 (dotted line). The solid line represents the theory result without ISI.

6. CONCLUSIONS

The aim of this paper has been to present some contributions in a field where most of the research is performed by private profit organizations and is thus not readily available to other researchers due to reasons of industrial secrecy. The results show how currently available devices can be used to develop an advanced project even in the absence of highly expensive technological support.

In the paper the implementation of an all digital 9600 bit/s Modem prototype that uses two Signetics 8X300 microprocessors to control the transmitter and the receiver has been described. The prototype was used to verify algorithms for signal generation and for Modem synchronization that were expressly developed for a completely digital Modem implementation. Details have been presented on the algorithms used in the Modem and on the software and hardware implementation. Particular attention has been devoted to the synchronization algorithms that only require one sample of the demodulated signal per baud period.

Experimental results have been shown that demostrate the good performance of the proposed algorithms and the feasibility of the proposed Modem architecture.

The research is still in progress; various algorithms for the adaptive equalization are being tested through extensive simulation and new components are being tried to check their suitability to the insertion in the Modem receiver.

APPENDIX

Computation of the preamble error indicator

Consider the receiver block diagram of fig. 14. The phase error that affects the reference carrier used for demodulation is:

$$\phi = \omega_o \tau \tag{A.1}$$

where ω_o is the carrier angular frequency and τ is the timing error. The in-phase and quadrature outputs from the modem receiver after demodulation can be written as:

$$y_P(t)=\cos\phi \sum_k \alpha_k h(t-kT)-\sin\phi \sum_k \beta_k h(t-kT)$$

(A.2)

$$y_Q(t)=\sin\phi \sum_k \alpha_k h(t-kT)+\cos\phi \sum_k \beta_k h(t-kT)$$

where h(t) is the overall baseband impulse response of the system.

The error indicator $F(\tau)$ must be evaluated using the above two signals.
Define the sampled modem outputs X_n and Y_n as:

$$X_n=y_P(\tau+nT)$$

(A.3)

$$Y_n=y_Q(\tau+nT)$$

and call $\hat{\alpha}_n$, $\hat{\beta}_n$ the receiver guesses of the transmitted point coordinates in the signal space α_n, β_n (the transmitted sequence is known, however alignment errors are possible).
Consider now the expression:

(A.4) $F_n = X_{n-1}\hat{\alpha}_n + Y_{n-1}\hat{\beta}_n$

that can be very easily evaluated in the receiver, and evaluate its ensemble average:

(A.5) $E[F_N] = E[X_{n-1}\hat{\alpha}_n + Y_{n-1}\hat{\beta}_n]$

Substituting (A.2) and (A.3), we find:

$$E[F_n] = \cos\phi \sum_k E[\hat{\alpha}_n\alpha_k]\, h[\tau+(n-k-1)T] - $$
$$(A.6) \qquad -\sin\phi \sum_k E[\hat{\alpha}_n\beta_k]\, h[\tau+(n-k-1)T] + $$
$$+\sin\phi \sum_k E[\hat{\beta}_n\alpha_k]\, h[\tau+(n-k-1)T] + $$
$$+\cos\phi \sum_k E[\hat{\beta}_n\beta_k]\, h[\tau+(n-k-1)T]$$

Consider now the preamble sequence. The statistical properties of the transmitted symbols are summarized in Table A1.

Also note that, due to the sequence symmetry, changing α_k into β_k and vice versa we still have the same results.

Assume now that the receiver guesses are correct, that is $\hat{\alpha}_k = \alpha_k$ and $\hat{\beta}_k = \beta_k$. Using the results of table A1 we find:

(A.7) $E[F_n] = 2\cos\phi \sum_{k=-\infty}^{\infty} h(\tau-T-4kT)$

Instead of evaluating the ensemble average, we can add all the values that the variable F_n can assume in the preamble phase. Only four values must be added, because of the 4T periodicity of the preamble sequence. They are all equally likely, so that:

(A.8) $\overline{F}_n = \sum_{i=1}^{4} F_{n-i} = 4E[F_n] = 8\cos\phi \sum_{k=-\infty}^{\infty} h(\tau-T-4kT)$

If the guessed sequence is not correct, so that, for instance $\alpha_k = \alpha_{k-1}$, $\beta_k = \beta_{k-1}$, we obtain:

(A.9) $E[F_n] = 2\cos\phi \sum_k h(\tau'-2T-4kT)$

where τ' is the sampling error inside one baud period. Considering that one cycle slip is necessary to align the sequences, the real sampling error is $\tau = -T + \tau'$, hence:

(A.10) $E[F_n] = 2\cos\phi \sum_k h(\tau-T-4kT)$

and similarly for other shifts in the sequence guess. Again note that the receiver knows the transmitted sequence, so that the only error in the guess can be in the alignment of the transmitted and received sequences. Define now:

(A.11) $E_n = X_n\hat{\alpha}_{n-1} + Y_n\hat{\beta}_{n-1}$

Using the same method it is easy to show that:

(A.12) $\overline{E}_n = 8\cos\phi \sum_k h(\tau+T-4kT)$

Thus, recalling (13), we find:

(A.13) $\overline{E}_n - \overline{F}_n = 8\cos\phi\, F(\tau)$

Note that we can more compactly write:

(A.14) $EF_n = X_n\hat{\alpha}_{n-1} + Y_n\hat{\beta}_{n-1} - X_{n-1}\hat{\alpha}_n - Y_{n-1}\hat{\beta}_n$

and

(A.15) $\overline{EF}_n = \sum_{i=1}^{4} EF_{n-i} = \overline{E}_n - \overline{F}_n = 8\cos\phi\, F(\tau)$

Similarly, by defining:

(A.16) $GH_n = Y_n\hat{\alpha}_{n-1} - X_n\hat{\beta}_{n-1} - Y_{n-1}\hat{\alpha}_n + X_{n-1}\hat{\beta}_n$

we have:

(A.17) $\overline{GH}_n = \sum_{i=1}^{4} GH_{n-i} = 8\sin\phi F(\tau)$

In order to obtain $F(\tau)$ it is necessary to estimate $\cos\phi$ and $\sin\phi$. Define:

Table A1

α_k	β_k	$P\{\alpha_k,\beta_k\}$	α_{k-1}	α_k	$P\{\alpha_{k-1},\alpha_k\}$	α_{k-2}	α_k	$P\{\alpha_{k-2},\alpha_k\}$	α_{k-3}	α_k	$P\{\alpha_{k-3},\alpha_k\}$
1	1	0.5	1	1	0.5	1	1	0.5	1	1	0.5
1	-1	0.25	1	-1	0.25	1	-1	0.25	1	-1	0.25
-1	1	0.25	-1	1	0.25	-1	1	0.25	-1	1	0.25

$$C_n = X_n[\hat{\alpha}_{n-1}+\hat{\alpha}_{n-2}+\hat{\alpha}_n]+Y_n[\hat{\beta}_{n-1}+\hat{\beta}_{n-2}+\hat{\beta}_n]+$$

$$+X_{n-1}\hat{\alpha}_n+Y_{n-1}\hat{\beta}_n$$

(A.18)

$$S_n = Y_n[\hat{\alpha}_{n-1}+\hat{\alpha}_{n-2}+\hat{\alpha}_n]-X_n[\hat{\beta}_{n-1}+\hat{\beta}_{n-2}+\hat{\beta}_n]+$$

$$+Y_{n-1}\hat{\alpha}_n-X_{n-1}\hat{\beta}_n$$

Then it is easy to show that:

$$\overline{C}_n = \sum_{i=1}^{4} C_{n-i} = 8\cos\phi$$

(A.19)

$$\overline{S}_n = \sum_{i=1}^{4} S_{n-i} = 8\sin\phi$$

The evaluation of the four quantities $\overline{EF}_n$, $\overline{GH}_n$, $\overline{C}_n$ and $\overline{S}_n$ can be done very easily in the modem receiver using a recursive algorithm.
The expression of $F(\tau)$ is then obtained by dividing either $\overline{EF}_n$ by $\overline{C}_n$ or $\overline{GH}_n$ by $\overline{S}_n$, depending on which of the two divisors is larger, in order to avoid precision problems in the division.

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CSO: 5500/2521

TELECOMMUNICATIONS AGENCY GIVING UP EQUIPMENT MONOPOLY

Stockholm SVENSKA DAGBLADET in Swedish 27 Sep 83 p 6

[Article by Thomas Jonasson]

[Text] The cordless telephone will be one of the National Telecommunications Administration's big new items in 1984. At the same time, that agency will give up its monopoly by allowing the cordless telephone also to be sold in general trade.

There are a number of different telephone models on the private market. It is legal to sell them--but not to use them. So anyone who uses one is a criminal.

That situation will change on 1 July of next year, when any businessman interested in cordless telephones will be able to sell them--provided that they have been approved by the National Telecommunications Administration.

Per-Axel Nygren, marketing manager for the National Telecommunications Administration's consumer market, says: "Consequently, we are going to face stiff competition."

Radio dealers and others can therefore purchase telephones from abroad, and if they are then approved by the National Telecommunications Administration, their use by customers will be legal.

The National Telecommunications Administration is also undermining its monopoly in other areas.

Per-Axel Nygren told SVENSKA DAGBLADET: "Yes, it is only a matter of time before it will be possible to buy even ordinary telephones on the private market."

Like other personnel at the National Telecommunications Administration, however, he is reticent about why the National Telecommunications Administration is taking these steps. We were referred to a press conference that will be held in Stockholm tomorrow (Wednesday).

The cordless telephone is already available in the United States, and next year it will be introduced in several European countries.

The cordless telephone is actually a portable radio transmitter. Instead of a cord, radio waves carry the conversation between the handset and the base telephone.

Three Hundred Meters

In a city environment, it is possible to talk from a distance of 300 meters, but in rural areas one can be several kilometers from one's base telephone and still have good audibility.

The portable unit is so small that it can be carried in one's pocket. This means, for example, that if the telephone rings while you are raking leaves, you do not have to run into the house to answer. It is possible to answer the telephone or even to place a call directly from one's yard.

And on 1 October 1983, the National Telecommunications Administration will also make another change. Effective on that date, anyone will be able to purchase an ordinary telephone. Until now, telephones could only be rented from the National Telecommunications Administration.

11798
CSO: 5500/2507

TELECOMMUNICATIONS AGENCY ENTERS HOME-COMPUTER MARKET

Stockholm DAGENS NYHETER in Swedish 8 Oct 83 p 6

[Article by Olle Larsen]

[Text] The National Telecommunications Administration's move into the home computer market has caused indignation in the industry.

Comments range from "distorted competition" to "totally crazy."

The National Telecommunications Administration is going to sell two home computers in its telephone stores. But one of them--the Atari 600 XL--has not been approved by the National Telecommunications Administration and therefore should not be sold. The other computer--the Sord M5--failed the agency's tests.

"It seems terribly strange to us, who are forced to comply with the National Telecommunications Administration's regulations, that they themselves totally ignore their own regulations," says one angry representative of the industry, who wants to remain anonymous so as to avoid unnecessary hassles with the telecommunications administration.

Ulf T. Sorander, chairman of the radio dealers organization, is also very critical of the National Telecommunications Administration's conduct.

"Many of our members who sell home computers are currently in a tough situation economically. Profitability has been made worse by strong competition, and now on top of that, we have to contend with the National Telecommunications Administration, which can set any price it pleases."

Ulf T. Sorander says: "The National Telecommunications Administration's monopoly position distorts competition. It is very unfortunate that the National Telecommunications Administration operates both as a supervisory agency and as a commercial operation."

Like many others in the industry, he has protested against the lengthy time it takes for the National Telecommunications Administration to test equipment and approve it. The waiting time is usually 6 months or longer.

Ulf T. Sorander says: "But naturally, the National Telecommunications Administration gets quick approval for its own brands, with the result that there is no competition on equal terms."

Spokesmen for the National Telecommunications Administration do not want to talk about whether the computers it intends to sell have been approved or not.

Per-Axel Nygren of the National Telecommunications Administration says: "But of course, the brands we sell will have to be approved."

Is it a good thing for the National Telecommunications Administration to approve the home computer that it will also sell?

"It is our radio division which approves them from the standpoint of radio interference, and we have nothing to do with that. The National Telecommunications Administration is quite large, and we deal with matters that are quite distinct in this case."

Per-Axel Nygren says: "The only thing I can find out is which equipment has been approved. It is only from our suppliers that I can really find out how the situation stands with their computers, and I must rely on them."

The Vic 64 is one home computer whose approval by the National Telecommunications Administration has been pending for a rather long time. Meanwhile, the Vic 64 has been sold, even though theoretically, it can neither be sold nor advertised.

A couple of days ago, the Vic 64 was granted an exemption until 1 November.

The Vic 64 also suffered a setback when SEMKO [Swedish Board for Testing and Approval of Electrical Equipment] rejected the transformer that carries current to its computer. At a rough estimate, over 1,000 of those transformers have been sold, although the exact number is not known.

SEMKO, which evaluates electrical safety and the danger of shock and fire, said the defect was not so serious that warnings would have to be issued concerning the rejected transformer. SEMKO was satisfied with assurances from the supplier, the Handic Corporations, that it would call back the rejected transformers and replace them with approved units.

The approved transformer for Vic computers carries the number BV220-0-4048. The number on the rejected transformer is BV220-0-03805.

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CSO: 5500/2506

COUNTRY TO HAVE WORLD'S MOST ADVANCED AUTOMATED PHONE NET

Stockholm DAGENS NYHETER in Swedish 8 Oct 83 p 6

[Article by Bengt Falkkloo]

[Text] Three years from now, people trying to place telephone calls to Stockholm will no longer have difficulty putting through their calls on weekday mornings. By that time, as a result of investments totaling several billion kronor, the largest telecommunications offices will have been computerized, and Sweden will have the world's most advanced telepnone network.

The National Telecommunications Administration conducted a study a couple of years ago to determine how well the traffic was moving. The results were not good. A full 13 percent of the calls from outside Stockholm were not getting through between 10 and 11 o'clock on weekday mornings.

Kjell Ohman, head of the Network Planning Section, says: "That is the hour when the load is heaviest. But despite the load, the number of incomplete calls was too high."

The National Telecommunications Administration's goal is to have a maximum fault rate of 3 percent.

"During the past 2 years, we have done more work and are now down to 6 percent. That is not good, either, but it is below the average for the very worst period."

Callers from Sundsvall, Ostersund, Falun, Uppsala, Norrkoping, and Helsingborg have been having problems.

Fell Behind

"In recent years we have been working to replace all the old exchanges. The new exchanges are digital or, putting it simply, small computers. There are no mechanical relays jumping back and forth. The new ones will be in operation within 3 years. But our big problem has been to make the change without interrupting operations. Everything has continued more or less as usual."

The National Telecommunications Administration makes annual forecasts of the needs that will exist. But in the matter of replacing exchanges, the capacity

required was underestimated, with the result that work in that area has fallen behind.

"The demand has increased faster than we anticipated, but we have nevertheless managed to maintain an acceptable level of service."

On the other hand, there have not been any problems with outgoing calls from Stockholm. The reason is that traffic is routed differently depending on whether it is going into or out of Stockholm.

There are two big exchanges in Stockholm: one in Hammarby and the other on Regering Street. One of them is now completely modernized, while work on the other is continuing. Incoming calls are separated and routed further depending on the originating area code.

According to Kjell Ohman, however, Sweden is the world's best telephone country when it comes to the number of telephones, rates, and modern equipment.

"If we look at the United States, for example, which is the country with which we usually compare ourselves, we are far out in front. The entire system is not automated over there as it is here, and it is also much more expensive. And we are still investing 3 billion kronor annually to expand and strengthen our system."

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